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ALPHONSO XIII., KING OF SPAIN.

THERE is always something pathetic in a boy king, and it is with a feeling of sadness that one looks upon the pictures of Alphonso XIII., the twelve year old King of Spain. The strange child hardly seems to ever have had the pleasure of being young, for he is prematurely old. He is small for his age and has a delicate physique; his pallid face is wan and pinched. In view of the terrible state of affairs in the Iberian Peninsula and in the colonies, it would almost be a mercy if this little boy, who has never harmed anyone, could find a resting place in the crypt of the gloomy Escorial, where there only remains space for one more royal tomb before he has known the horrors of civil war and of the menaces from outside.

Alphonso XII. was brought back from exile because the Italian Amadeo had proved a failure. Alphonso married his first cousin, the daughter of the Duke of Montpensier. After a few months she died, leaving Alphonso disconsolate and childless. The necessities of state required him to provide an heir, so he was easily convinced of the urgency of an immediate second marriage. The choice of a consort for a reigning monarch is always an embarrassing one for reasons of state, of family and of religion, which have always to be duly considered; and in this instance there was found to be only one woman whom it was practicable for him to marry. This was the Archduchess Maria Christina, of Austria. Alphonso died unexpectedly in 1885. Two children, both daughters, had been born to the Queen, but, fortunately, the king left a posthumous son and heir. The death of Alphonso had been awaited as a signal for a civil struggle, and the Carlists saw their hopes dashed to the ground when the new heir to the Bourbon throne was born. Alphonso XIII. was born at Madrid, May 17, 1886, in the presence of the Ministers of State, his cabinet officers and members of the Regency and Privy Council. This rather extraordinary proceeding was the result of a report which had circulated that a bogus heir to the throne was to be palmed off on the Spanish people, so that when the unhappy child first opened his eyes he found himself in the midst of a cabinet council. Each Spanish queen had, theoretically, been subjected to this ordeal, but never, at least in modern times, had this been strictly enforced. The Spaniards rallied around the Queen Regent and the baby king, doing everything in their power for the continuance of the Bourbon regime.

The boy king knows that his situation is a pathetic and a precarious one. He has had no happiness in his short life and he knows there is no one in the Peninsula whom he can count upon except his mother, a helpless woman and a stranger to Spain. From the time he left his cradle the little fellow has been surrounded by the stiff ceremonials of the Spanish. The boy king can have no playmates, because in the kingdom he has no peer. He knows that politics is a game that is more cruel than war and that Spaniards are past masters in the arts of diplomacy and duplicity. According to the law in Spain, the king attains his majority at the age of fifteen years; so, but for the Cuban trouble and the political dilemma which is a result of it, he might have ascended the throne with some prospect of a fairly peaceable reign. As it is, the country is bankrupt; the war in Cuba is at an acute stage; the insurrection in the Philippine Islands is serious, and withal there is the menace of the United States. The Carlists hope that little Alphonso may never live to wear his father's crown. Should the king die, no woman with Bourbon blood in her veins will be allowed to ascend the throne, as the very disastrous reigns of Queen Christiana and Queen Isabella II. are fresh in the memories of all. The probable solution of the situation is that, if Alphonso should die, his eldest sister would marry Don Jaime, the son of Don Carlos, the Carlist Pretender. This would satisfy both parties and free Spain from the possibility of civil war. The poor little king upon whom so many hopes are placed signs himself Leon Ferdinand Marie Jaime Isidore Pascal Antonio, King of Spain, of Castile, of Leon, of Aragon, of the Two Sicilies, of Jerusalem, of Navarre, of Grenada, of Toledo, of Valencia, of Galicia, of Majorca, of Minorca, of Seville, of Cerdena, of Cordova, of Corsica, of Lucia, of Murcia, of Jaen, of Algarves, of Algeciras, of Gibraltar, of the Canary Islands, of the Indies, East and West, of India and the Oceanic Continent, Archduke of Austria, Duke of Burgundy, of Brabant and of Milan, Count of Hapsburg, of Flanders, of Tyrol, and Barcelona, Lord of Biscay and Molina, etc. It certainly must be very oppressive, even for a king, to have so many titles as this, but who knows, perhaps, but tomorrow he may sign himself "Alphonso Garcia y Perez," which name his father entered many times on the books of second-class hotels during his long years of exile. One peculiar thing about the titles of the King of Spain is that a large number of the titles refer to places which have been lost to the Spaniards through bad government and by the fate of war. For our engraving we are indebted to The Illustrated London News.

HIS MAJESTY ALPHONSO XIII., KING OF SPAIN.

THE BACTERIUM OF AMBERGRIS.

M. BEAUREGARD announces the result of his investigations on the bacteriology of ambergris, a substance highly valued in perfumery, that is nothing else than a concretion developed in the intestine of the sperm whale. Says the Revue Scientifique: "He has discovered a vibrio (spirillum recti physeteris), mobile and of great variety of form, whose morphologic and biologic characteristics he has studied. This vibrio, which resembles in many respects that of Asiatic cholera, has been found alive in a large concretion of ambergris weighing nearly 8 kilogrammes [17½ pounds] and preserved for at least four years. Ambergris acquires its sweet odor only after being freed, at the end of a long time, from an intestinal substance which masks its perfume when it is fresh. M. Beauregard supposes that the destruction of the disagreeable matter of the ambergris comes about by means of the microbes that find a favorable place of growth in this substance. It is certain, says he, that these species of vibrios live in general in decomposing matter. In any case, it is interesting to find in the intestine of the sperm whale, an animal essentially aquatic, a form of vibrio very nearly related to that which causes cholera in terrestrial species."

The following figures relating to the Ostend electric tramway are given in Engineering. The accumulator system has been adopted, each car being fitted with 12 cases of nine Laurent-Cély cells each, which have a capacity of 140 ampere hours and can give a discharge of 50 amperes. Charging takes from three-quarters of an hour to two hours. The cars weigh 7¼ tons each, batteries excluded, and can accommodate 50 passengers. The motors, of which there are two to each car, are of 18 kilowatts capacity, and were supplied by the Westinghouse Company. They drive the axles through gearing which reduces the axle speed to one-fifth that of the motor spindle. One charge of the battery is sufficient for a run of 44 miles. The tractive force is found to be 17·6 lb. per ton at starting and 8·8 lb. per ton when running on the level at a speed of 11 miles per hour.

PREHISTORIC BRONZE.

By R. L. PACKARD.

THIS alloy of copper and tin, which is familiar to us principally as the material of which statues and many ornamental articles are made, was used besides in prehistoric times for weapons, tools and utensils, which are now made of iron and steel. It is a curious fact that the manufacture of bronze was discovered and the alloy was widely known and used before the art of smelting iron from its ore was discovered. The explanation of this fact may be that copper, which is the principal ingredient of the alloy, is frequently found "native," that is, in the metallic state, so that the attention of prehistoric men was early attracted to it, and many of its ores are also likely to attract notice from their color or weight; and, moreover, copper is more easily extracted from its ores by fire than iron. Whatever the explanation may be, the bronze industry grew to great proportions in prehistoric times, so that the alloy was in general use in Asia and Europe when history begins, and even after iron had been long in use for weapons, implements and tools, in later times, bronze was still employed for artistic purposes in enormous quantities in the civilized countries surrounding the Mediterranean. At the triumph of Sp. Carvilius over the Etruscans in 293 B. C. that general placed 380,000 pounds of bronze in the Roman treasury, besides paying a large amount of it in coin to his army. One small tribe paid him a fine comprising 100,000 pounds of copper among other things. At the same time Papirius, the other general, displayed 2,033,000 pounds of copper taken from the Samnites. This was the result of only one of the numberless wars in which Rome was perpetually engaged.

Before the invention of bronze all mankind used stone for axes, knives, hammers, spear and arrow heads, etc. Among certain African tribes bronze was never used for these purposes, but iron superseded stone for weapons and tools immediately. But in Asia, Egypt and Europe, the order of succession was stone, bronze and iron, and it is a curious speculation to inquire where and when the transition from stone to metal took place. In some regions we shall find that the change was evidently a comparatively speedy one, like the adoption by our Indians of European arms and tools in place of their own, but elsewhere evidence has shown that the change was gradual and must have required a long time.

No more striking illustration of this succession from stone to bronze could be found or invented than is given in the account of some archæological discoveries near Rome by Signor Rodolfo Lanciani in his book on Ancient Rome. It is as if the ancient well he describes had been purposely left as an object lesson on this subject. He says: "There was a well known custom in ancient times of throwing votive offerings (sacrae stipes) into lakes, rivers and springs, which were sacred to the gods, or were famous for their mineral hygienic properties. The custom dates from very remote ages, as the following discovery will testify. In 1852 the Jesuit fathers, owners of the celebrated sulphur springs called by us 'Sorgenti di Vicarelli,' by the ancients Aquae Apollinares, on the west border of the lake of Bracciano, sent from Rome a gang of masons to clear the mouth of the central spring, and to put the whole into neat order. In draining the well, a few feet only below the ordinary level of the waters, they came across a layer of brass and silver coins of the fourth century after Christ. Then they discovered a second layer of gold and silver imperial coins of the best period, together with a certain quantity of votive silver cups. In the third place, they came across a stratum of silver family or consular coins, belonging to the last centuries of the republic, and under this they found bronze coins, sextants, quadrants, trients and so forth. Seeing that there remained nothing but brass to plunder, after having partaken of the previous booty in equal shares, the masons resolved to announce their discoveries. It is unnecessary to say that when Padre Marchi, the well known numismatist, ran to the spot, he found only a few hundred pieces of the aes grave signatum, the earliest kind of Roman coinage. Under these there was a bed of aes rude, that is to say, of shapeless fragments of copper, a kind of currency which preceded the use of aes grave signatum. At the bottom of the well, under the shapeless fragments of copper, there was nothing but gravel; at least the workmen and their leaders thought so. It was not gravel, however; it was a stratum of arrow heads and paal stabs and knives of polished stone, offered to the sacred spring by the half savage people settled on the shores of the Lago di Bracciano before the foundation of Rome. This admirable chronological series of votive offerings began with the age of stone and, perhaps, with the first appearance of mankind in central Italy, and ended with the fourth century of the Christian era."

It is, perhaps, worth while to add a word upon the views which have become accepted in regard to the use of stone in early times. It is now almost popularly known that it has been inferred from the study of the contents of certain caves which were occupied by prehistoric men, of prehistoric burial places and dwelling sites, of articles found in alluvial deposits and lake bottoms in Europe, together with the results of excavations of prehistoric cities, especially those made by Schliemann in Asia Minor, that there was an advance among prehistoric peoples from a very rude to a more highly developed stage of industrial development, analogous to progress, in this respect, in the historic period. This conclusion is drawn from a comparison of the earliest with those of later prehistoric stone industries, so that it has been convenient to classify the use of stone weapons and implements into two periods, an earlier or paleolithic and a later or neolithic period, the articles of stone manufacture during the former period being characterized by rude chipping and by having an unfinished appearance, while those of the later were ground or polished and in other ways show superior workmanship. The relative ages of these different periods in Europe were determined, to a considerable extent, by their geological occurrence, so that, as far as evidence is concerned, the succession of these stages of prehistoric manufacture was ascertained in the same way as the succession of different species of animals and plants in geological history. Or rather, to be exact, the relative ages of the deposits of articles of stone and bone were determined by geological evidence. It is only by inference that anything can be said of the intellectual and moral status of the makers of these articles. Nobody knows anything with certainty about prehistoric tribes, but it is probable that the improvement in manufacture under consideration was introduced by new tribes having superior mechanical skill. If such was the case, nothing is proved by the discoveries above mentioned as to progress. In fact, prehistoric men are so called only because there was no one to describe them, and not because it is supposed that they possessed any peculiarities which made them different from other savages. They ceased to be "prehistoric" as soon as they were mentioned in any way. The accounts of the early Scythians in Greek literature and of some of the wild tribes in the Germania of Tacitus, the Fenni for example, may be good descriptions of prehistoric tribes for all we know, and our Indians were prehistoric before they were described by Europeans. How superior in intellectual attainments to all these wild tribes were the earliest Assyrians or Egyptians, or the Peruvians, all of whom used stone implements and may also be called prehistoric! It is obvious, therefore, that it is possible to draw too wide conclusions from the occurrence of articles of manufacture, and that the discovery even of bronze articles in a given region does not necessarily imply intellectual superiority in their ancient owners without other evidence.

The use of stone for implements and weapons has been found of universal geographical distribution. The natives of this continent, and the inhabitants of the other parts of the earth which have been visited by Europeans since the era of geographical discovery in the fifteenth century, were all found to be in the neolithic or later stone period. In Europe and the East this primitive stage lasted through a period of unknown duration in prehistoric times which has been classified, conveniently if indefinitely, into an "age," after which stone was superseded by bronze, which gave a convenient name to another "age," which in its turn was succeeded by that of iron. This succession of stone, bronze and iron depends in great measure on mineralogical conditions and could only obtain in regions where suitable ores for the production of the different metals were indigenous or could be conveniently procured by way of traffic. It need not, therefore, be looked for universally.

The possession of the useful metals as part of the equipment of life has been taken to indicate the degree of civilization of a people. That is to say, in the case of prehistoric people, for example, the occurrence of bronze weapons, ornaments and implements, in prevailing or considerable quantities among similar articles of stone in prehistoric finds has been found so frequently accompanied by evidences of an improved condition of life among the vanished people that the discovery of such bronze articles in new instances would allow the inference that the people which possessed them was also in superior circumstances as regards ease of living, compared with a people which had only stone weapons and implements. And in Europe and the East the same reasoning would apply a fortiori in the case of iron. The conclusion must be drawn, however, with certain restrictions, for it by no means follows that the possessors of bronze whenever found were equally advanced in culture, because prehistoric trade carried the manufactures of a more accomplished people to others less advanced, just as commerce does in modern times.

It appears that there was not an abrupt transition from one of these stages of industry to another, at least among the people where it originated, but that it must have been gradual, and bronze only supplanted stone by degrees. Indeed, even in Europe, where the change was comparatively rapid, survivals of the "stone age" have persisted into modern times. Stone weapons were used at the battle of Hastings (or Senlac), in 1066, and in certain simple peasant industries small stone implements, preserving their ancient purpose, were still employed in southern Germany until a few years ago, and may still be in use. Stone arrow heads were in use in Siberia in the last century. Geographically, too, in ancient as in modern times, there was no simultaneous or even contemporary transition from the use of one material to another, but people in one region—in Europe, for example—were still in the stone age long after the East had reached the bronze and, perhaps, even the iron stage of industry. The succession of stone, bronze and iron, therefore, while serving to mark successive epochs in Europe, where the classification was promulgated, as well as in the East, must not be taken as having anything more than a relative chronological value for a given region. Moreover, while in the East this succession may have been very slow, the result of the natural growth of an autochthonous industry, in Europe the bronze appears as an importation of an already manufactured article, and it is found intruding abruptly upon the stone.

Indeed, the bronze "celts," spear heads, etc., and even the moulds in which they were cast, which have been collected in museums in Europe, and are figured in archæological works, have a strong family likeness to those found by Chantre in the Caucasus and to the Siberian copper and bronze articles which are shown in the fine plates of Martin's L'age du bronze and Musée du Minoussink. This striking resemblance, in certain respects, among articles produced in regions so remote from each other, suggests the former existence of an art or mystery which was carried by its practitioners from one place to another. It is as if the prehistoric bronze founders were members of a guild and traveled from one country to another. Prehistoric European bronze does not necessarily indicate an indigenous invention.*

Archæological discoveries first established the order, stone, bronze and iron, and this order has come to be accepted almost as a natural one. Discoveries in recent years, however, have shown that in some regions in Europe the middle stage of the series is wanting, and iron succeeded stone immediately, as it did in Africa, or copper took the place of bronze. There would be nothing surprising in this nonconformity, if we reflect that bronze is essentially an alloy of copper and tin, and that, while the ores of copper are found in many places, tin ore is of rare occurrence; so that the production of bronze would naturally be confined, at first, to the regions where tin ore occurs, or whither it could be carried to mix with the copper at the smelters. On the other hand, from mineralogical considerations, we should expect to find copper used before bronze, because copper is found native in many parts of the world, and would be likely to attract the curious attention of primitive man elsewhere, as it did that of the natives of this continent before its discovery by Europeans.

Copper also, at first, shared with gold and silver their ornamental character, and, like them, was regarded as a precious metal before the discovery of its metallurgy and the abundance of its ores placed it among the useful ones.

The Indians of the northern part of this continent used the native copper from the Lake Superior district, and no smelting was necessary to produce the metal. Prehistoric people in Asia and Europe, however, knew how to extract the metal from its ore.

After smelting was once known, the comparative abundance of the ores of copper would furnish a ready source of the metal for the uses to which it is adapted. This a priori reasoning is confirmed by the discovery of copper ornaments, implements and weapons in situations which show that this manufacture preceded that of bronze, and, also, by the fact that prehistoric copper mines have been found in various parts of Europe. Schliemann found copper articles, but no bronze, together with the stone implements in the first and second (the oldest) prehistoric cities at Troy. In consequence of the abundant discoveries of copper articles in recent years and the evidence of the wide extent of its early use, some writers are inclined to create a copper "age" to precede the bronze. It is possible that, if analyses were made of many of the articles labeled "bronze" in museums, it would be found necessary to relabel them.

When or among what people in the East bronze was invented is not certainly known. Its prehistoric antiquity is assuredly very great; but all that can at present be said of the date of its origin is entirely vague. It is to be placed somewhere in the uncertain interval between the period when the events can only be referred to geological epochs and that when time can be measured by centuries.

Other evidence on this point, besides that derived from archæology, is offered by students of philology. Their argument is the now familiar one that, if a given thing was known to a primitive family of languages, the stem of its name word would be common to the languages of the various races of that family after dispersion had taken place. When it was sought to determine the relative antiquity of bronze and iron in this way, interesting, if sometimes perplexing, results were reached by philologists. These results confirm the conclusions of archæologists, and it appears that there is not so much conformity in the succession of stone, bronze and iron as was formerly supposed. Dr. Schrader (Schrader and Jevons, "Prehistoric Antiquities of the Aryan Peoples") is of the opinion that bronze was unknown to the Indo Germanic family before dispersion took place.

The source of the tin for the earliest prehistoric bronze has been traced to a few localities in the East. V. Baer (Archiv für Anthropologie, ix, p. 265) made a special interrogation through the Russian army officers as to the existence of tin mines in Persia, Turkistan and toward the Hindu-Kush. The reports showed that there were extensive tin mines in Khorassan, and he concludes that they supplied the tin for the large quantities of bronze found in the ruins of Assyria and Babylon. In this region he remarks tin was used by the Drangians according to Strabo. Lenormant, quoted by V. Baer, says that the Assyrian word for tin is Kasazatirra, from which the Greek word Kassiteros may be derived as well as the Sanskrit and Arabian names.

Tin is also found in the Urals, and the prehistoric bronze industry of Siberia must have been very considerable, as shown in the work of Martin before referred to.

In subsequent times tin was brought from Ceylon, Southern India, Spain and Cornwall by the Phenecians, who traded with the latter countries for that metal as early as 1200 B. C. The production of bronze was the only metallurgical industry of any importance for an unknown length of time, and many foundries for remelting and casting it have been discovered in various parts of Europe. At Bologna alone 14,000 pieces of bronze were found broken ready for casting. Fifty-seven prehistoric bronze foundries have been found in France and many more in Scandinavia, Spain and elsewhere. All these establishments only recast the imported bronze. It is not yet known where the alloy was made for export.

The following analyses will show that there was no constant or conventional composition in the earliest bronzes and that the proportion of tin in the earliest specimens was smaller than in the later. The analyses of the bronze articles found by Schliemann in the prehistoric cities on the site of Troy are of great importance, since the articles were collected with a full understanding of their archæological significance.

The analyses are as follows. A nail from the first (lowest) city gave:

Copper	97·83
Tin	0·21
Iron	0·90
Nickel	trace
Cobalt	trace
	98 94

Another nail gave:

Copper	98·80
Tin	trace
Iron	0·75
Sulphur	0·13
	99·68

Analyst: Prof. W. Chandler Roberts-Austen, F.R.S., assayer to the Royal Mint.

Prof. Roberts-Austen supposes the trace of tin

* That bronze had at one time been used instead of iron for all purposes was well known among the early Greek writers, and the same understanding was prevalent among educated Romans at a much later period. Lucretius says, in a well known passage: "Et prior aeris erat quam ferri cogitus usus." (The use of bronze was known before that of iron.) He may have known this fact from religious tradition. In Rome, even after Christianity had become the religion of the state, iron was excluded from the temples of the old religion, and only bronze utensils were used. Iron had never been permitted in them, either for sacrifices or in building. So, during the colonization period, the limits of towns were determined religiously by a furrow, traced by a bronze plow, long after iron plows were in use. (References collated by Lanciani.)

in these specimens to be accidental, and adds: "If the implements were used as nails, it would appear that they belong to a pre-bronze age and that the makers of them were not familiar with the fact that copper is hardened by the addition of tin." These analyses settled the question whether copper or bronze was the material of the articles found in the first and second (the oldest) cities at Troy.

Other specimens from these cities analyzed by Schuchardt, of Görlitz, also contained hardly any tin, one specimen giving only 0·45 per cent., while another was almost pure copper, containing 99·55 per cent. of the metal.

Prof. Rammelsberg analyzed specimens of bronze battle axes from the Trojan cities which contained from less than 3 to a little over 4 per cent. of tin, with traces of lead and iron.

Prof. Rudolf Virchow, commenting on these alloys, observes that they contain so little tin that they do not answer at all to the common mixture of bronze.

A number of other bronze articles from these finds analyzed by Rammelsberg and Prof. Roberts had from 0·64 to 8·64 per cent. of tin.

Berthelot (Chimie des anciens, 1889, p. 224) examined an ancient Chaldean statuette found at Tello by M. de Sazec, to which the date 4000 B. C. was assigned, which he found to consist only of copper instead of bronze, as he expected. He says that the figurine of Tello seems to show that tin was unknown at the remote period when that object was cast, but, he adds, more analyses are necessary to settle the question, as the absence of tin may have been due to other causes. He also analyzed a fragment of the scepter of King Pepi I. (sixth dynasty) and found it to be copper. (Ann. Chimie et Phys., 6 sér., t. xii, p. 129).

Objects belonging to the twelfth dynasty gave Gladstone (Pro. Soc. Bibl. Arch., vol. xii, p. 237) from traces of tin to 2·16 per cent., while later specimens (eighteenth dynasty) gave as high as 7·29 per cent. The presence of arsenic in the Egyptian bronzes is noticeable, there being as much as 4 per cent. of that metal in one specimen.

Still later Egyptian bronzes gave as high as 14 per cent. of tin, or more than the conventional proportion for bronze.

Lead appears in some of the Egyptian bronzes, which amounted to 4·5 per cent. in a statue of Osiris. Wiedemann concludes that the first metal employed by the Egyptians was copper, not bronze. Copper was first alloyed with tin, he thinks, at the epoch of the new empire, and this period marks the beginning of Egyptian bronze.

It appears from the foregoing collection of analyses that experiment had not ascertained a conventional proportion of tin and copper for weapons at the time the articles found in the lower cities at Troy were made. The bronze of Mycenæ and Tiryns was of later manufacture than that found in the lower cities at Troy. The analyses of the former made at the Royal School of Mines under the supervision of Dr. Percy show that both copper and bronze were used at Mycenæ, the former being employed for domestic utensils and the latter for weapons.

There is, of course, no evidence to show that the varying proportions of tin in prehistoric bronzes were due to design, as in the case in modern bronzes, where different proportions are used purposely to produce certain effects, as in making bell metal, bronze for art castings, for parts of machinery, etc. But the alloys made by the Greeks and Romans in historical times for statuary, coins and other purposes varied in their composition, doubtless, for the same reason that modern bronzes do, and it may well be that the most advantageous proportion of tin to copper for weapons had become known in the times preceding history, as may be inferred from the Mycenæan bronze. There is no reason why prehistoric bronze founders in the countries east of the Mediterranean should not have been as skillful metallurgists as the Chinese at a later period, if indeed they were not the common forerunners of both Chinese and European bronze founders.

Although the discovery of smelting and the beginnings of metallurgy in the East are lost in antiquity and the earliest methods are only matters of conjecture, we are possibly much nearer such beginnings on this continent. The natives of Mexico and Peru were acquainted with a rude form of metallurgy when the Spaniards discovered them. It is believed that they were in an incipient bronze age, for they made bronze articles or copper articles carrying a little tin—many of which have been preserved and are now in museums. This important point of departure in industry may, therefore, be seen only at second hand, by studying the accounts of the earliest explorers of Mexico and Peru with a view to recovering the metallurgical methods described in them. We also have analyses of some of the bronze articles brought from those countries of indigenous manufacture and pre-Columbian date. The Peruvian and Chilean articles gave the following results (analyses in Wilson's Prehistoric Man):

	Copper.	Tin.
A chisel from the silver mines at Cuzco	94·00	6·00
A knife from a grave at Atacama	97·87	2·13
Another	94·00	6·00
Crowbar-like implement from Chile	92·38	7·62
A knife from Amaso	95·06	3·96
An ornament from Tringilia	95·44	4·56
Bodkin from a grave	94·79	3·30

The low percentage of tin in these alloys recalls the bronze of the earlier prehistoric cities of Troy.

As far as mineralogical probabilities are concerned, we might expect a bronze age in Peru, Chile, and Mexico, because both tin and copper are found in those countries, and we know that the aboriginal inhabitants, even of the northern part of this continent, were as keen to discover and use the minerals which could be made serviceable to them before the advent of the whites as they were quick to appreciate and adopt the weapons of the latter as soon as they learned how to use them. Some of the ancient mines of the North Americans were astonishingly extensive, e. g., the copper mines on Lake Superior, the mica mines of North Carolina, soapstone quarries in various localities and the enormous flint diggings of Ohio, to mention only a few. These were their great mines, but they used besides as many other minerals for various purposes as they found were serviceable and they knew how to select and work them with admirable skill. There would be nothing surprising, therefore, in finding that the semi-civilized Mexicans and Peruvians had selected and used so noticeable a mineral as tin stone as well as copper ores. The important technological feature in their material culture is that they knew smelting, while their northern contemporaries were ignorant of that art as far as we know. Whether the art of smelting, and especially the manufacture of copper-tin alloys, was an original invention of the Peruvians, was adventitious, or came with them to this continent, is a question which is involved in the wider one of the origin of that people itself.

Washington, D. C.

MAN IN RELATION TO THE GLACIAL PERIOD.*

As there appears even now to be a doubt in the minds of some as to whether man reached Britain before, during or after the time known to geologists as the "glacial period," it might be well on the present occasion to re-examine some of the evidence which has been brought forward to prove the presence of pre-glacial man, especially from those areas in Britain which are now admitted to contain glacial deposits, or to have been overspread by ice and snow in the glacial period.

The most important evidence yet obtained is that which has been furnished by the ossiferous caverns in the glaciated areas; but the occurrence in the same areas of the remains of extinct mammalia, which are now admitted to have been contemporary with the cave man, buried under great thicknesses of glacial deposits, must also have an important bearing on the question.

All the evidence tends to show that the so-called tertiary and quaternary periods merged gradually into each other, and were not separated by any great break in Britain. The higher mountains, before the close of the tertiary period, must have been covered in part by ice and snow, and the so-called glacial period can only have a chronological importance as indicating the increased intensity and climax of that cold condition gradually ushered in at the earlier time. For the same reason there is no marked and definite line separating the fauna of the Pliocene from that of the Pleistocene, for we find remains of the animals of the warmer period closely associated with those of the colder in the same deposits and under conditions which show clearly that they lived in those areas at the same time.

NORTH WALES AND THE NORTHWEST OF ENGLAND.

It is generally admitted that during the latter part of the Pliocene period the mountains of North Wales stood at a considerably higher elevation than they do at present; therefore it is but natural to suppose that during that time the streams which flowed from them gradually deepened, widened, and also possibly carved out some of the pre-glacial valleys. The carboniferous limestone along the flanks of the mountains, which had at an earlier time been much broken and crushed by earth movements, now suffered from the additional effects of subaerial action, and wide fissures and caverns were gradually formed in it. In time some of these, as the streams found outlets at lower levels, would be left comparatively dry, and would then be suitable for habitation by man and beast.

In nearly all those caverns where remains of the extinct animals and the implements of contemporary man have been found there is some amount of sediment underlying the remains. This must have been left there by the streams or floods which also deposited the material which filled up the narrow descending fissures, thereby making a fairly level floor to the caverns before occupation. This material in every case, unless where there is evidence of its having been subsequently disturbed, consists entirely of such local materials as would be brought down by the streams from the immediately adjoining higher ground. When the higher caverns were first occupied by hyenas, it is probable that there was comparatively little ice or snow on the mountains, and many of the animals which lived in the valleys and on the plains extending from them were southern types. Gradually, however, as the cold increased, northern forms appeared on the scene, and a commingling of the two groups took place.

The geographical features in the west and northwest in later Pliocene times may be briefly summarized as presenting high mountainous areas in Wales, Cumberland, the south of Scotland and in parts of Ireland bordering the Irish Sea and St. George's Channel, with extensive plains traversed by great rivers in the areas now submerged, between the west coast of England and Wales, and Ireland. The conditions here were then in every way suitable to form feeding grounds for herds of the great mammalia, and indeed such as could never have been repeated afterward in these areas either in late glacial or in post-glacial times.

Animals from the southeast could reach the northwestern plains across Cheshire and the lowlands in the center of England, and others from the south by the plains on the west coast of Wales. In this way northern and southern animals would in a sense freely commingle and be afterward driven to more southern areas together as the cold increased, and the conditions became more and more unsuitable to them. At first, in the mountains bordering these plains, when only their higher parts were covered with ice and snow, glaciers would occur only in the higher valleys; but as the cold increased they would become confluent with those from adjoining areas, and in time reach the plains and there coalesce to form, perhaps, as has been suggested, one vast sheet reaching across from England to Ireland. Most of the animals, ere the last stage had been reached, would, of course, have disappeared from those parts toward more suitable southern areas.

That the foregoing is, in brief, the history of the incoming of the glacial period in the northwest is evident from the deposits which have been found in and about the caverns, and in sections at various points on the hills, in the valleys and around the coast of North Wales.

Wherever the earlier materials have been preserved, especially at high levels, they are seen to consist entirely of local materials, i. e., such as would be derived from the immediate neighborhood or carried down by streams or ice from the adjoining higher ground.

Over this, and partly mixed up with it in the areas not reached by the northern ice, there is an admixture of materials from other Welsh districts, and in the valleys opening out to the north and along the coast there is the further admixture of erratics from northern areas. It is an interesting fact that the boundary line in the Vale of Clwyd reached by the northern erratics is very little more inland than the area in which the caverns we have explored occur.

Of the history of the subsequent changes I need say but little; but it seems to me that there is fairly good evidence to show that a considerable subsidence did take place toward the close of the glacial period, and that this was afterward followed by a certain amount of upheaval in the same areas.

The presence of such thick deposits of drift, below the level of the sea, at the entrance to the Vale of Clwyd, with bones of the early Pleistocene mammalia at the very base, is a fairly sure test of a stage of subsidence, and it is also difficult to account for the finding of numerous foraminifera in clays at a height of about 200 feet above present sea level around the coast unless alternating movements of subsidence and upheaval took place. The marine sand with broken shells at high levels, formerly looked upon as sure evidence of subsidence to that depth, must not be relied upon too confidently, as in no case has it been clearly shown that the organisms lived in the positions where the shells are now found. In some cases there are also fairly clear indications that the deposits have been transported to fairly high levels by ice which had passed over and scraped up materials from the sea bottom.

It seems safer, at present, from the evidence which has been brought forward of late years by so many competent observers, to assume that toward the close of the glacial period the earth movements produced changes only of a few hundred feet rather than the greater depression and upheaval suggested by the earlier geologists.

EARLY PLEISTOCENE CONDITIONS ON THE EAST SIDE OF ENGLAND.

On the east side of England, as on the west, there were at this time great plains, extending out from the valleys, and much of the area now covered by the North Sea must have been dry land where northern and southern animals commingled. That this was the case is shown by the finding of their remains in close association in the hyena den at Kirkdale and in other caverns in Yorkshire. Prof. Phillips many years ago came to the conclusion that the Kirkdale Cave was occupied in the "pre-glacial condition of the land which is now Yorkshire," and he also maintained that the lowest Hessle gravels which rest upon the chalk, and which contain mammoth and other remains, and are covered by bowlder clay, are pre-glacial in age.

Mr. G. W. Lamplugh's careful researches seem to show clearly that the Sewerby gravels, which have yielded so many Pleistocene remains, are at the base of the glacial series in that area. He says of the fauna at the base of the drift at Sewerby: "It is essentially the fauna of the Kirkdale Cave."* In his conclusions, given in the same paper, when referring to the physical conditions prevailing in the area during the formation of the drift deposits, he says: "At a period not long anterior to that of the glaciation of the coast, Flamborough Head was in existence as a bold promontory jutting out into a sea whose level was slightly above that of to-day. Most of the mammals characteristic of the glacial period were already living, and tenanted the interior in large numbers. The climate was moist and not very severe, the prevalent winds, as shown by the sand dunes of Sewerby, being from the west or southwest. After the land had remained for a long time stationary, a slow elevatory movement set in, and the climate become much colder; so that the chalk surface was disintegrated by frost and eroded by sudden floods, which spread thick beds of muddy detritus over much of the low or slightly sloping ground in the vicinity. Meanwhile the bed of the North Sea was being rapidly filled with ice through the great extension of the Scandinavian glaciers, till at length the Scotch and Scandinavian ice coalesced, and what remained of the North Sea was well-nigh ice locked."

Although some southern forms whose remains have been discovered in the forest bed on the Norfolk coast do not appear to have reached much further north than that area, this does not, in my opinion, make it in any way certain that even these were not, in part at least, contemporaneous with the so-called mixed early Pleistocene fauna of the more northern districts. It is also an important fact that many of the most characteristic animals whose remains have been discovered in the caverns in North Wales and Yorkshire are now always included in the fauna of the forest bed. The position of the forest bed of Norfolk under high cliffs of bowlder clay is also very similar to that of the lower deposits near the entrance to the Vale of Clwyd, containing Pleistocene remains and trunks of trees in like manner covered over by a great thickness of glacial drift. It may also be compared with the forest bed in Holyhead Harbor buried under "stiff blue clay," in which two perfect heads of the mammoth were found when the excavations for the railway were made in 1849. The tusks and molars were buried two feet deep, in a bed of peat three feet thick, with stumps and roots of trees.†

It may be well to mention that the following mammals, whose remains have been found in caverns in North Wales, Derbyshire and Yorkshire, are now generally given as forming a part of the fauna of the Norfolk forest bed, and that several of them, such as the glutton, musk sheep and mammoth, must be considered typically northern animals. The list is taken from those published by Prof. Boyd Dawkins or Mr. E. T. Newton, and there are animals which may be classed as characteristic of arctic, temperate, and hot climates. Animals whose remains have been found in caverns in association with human implements, and which are stated also to occur in the Norfolk forest bed, viz., Elephas antiquus, E. primigenius, Hippopotamus amphibius, Equus caballus, Sus scrofa, Bison, Ovibus

* "Evidences of the Antiquity of Man furnished by Ossiferous Caverns in Glaciated Districts in Britain." Abstract of Presidential Address to the Geological Society, delivered at the annual meeting, February 18, by Dr. H. Hicks, F.R.S., and published in Nature.

* Quart. Journ. Geol. Soc., vol. xlvii (1891).

† "Principles of Geology," Lyell, vol. i (1867), p. 545.

moschatus, Cervus elaphus, Cervus capreolus, Megaceros, Machairodus, Canis lupus, C. vulpes, Hyæna crocuta, Ursus spelæus, Gulo luscus, Lutra vulgaris, Arvicola amphibius.

When the cold increased, the animals on the east coast, as on the west side, were driven further and further south, and those least able to bear the increased severity of the climate were the first to migrate from the various areas. The southern forms may consequently be looked upon, for the areas in which they have been found, as the oldest fauna; but it is reasonable to suppose that they were contemporary with the more northern forms, which at that time lived in other districts where the conditions were more suitable to them. When the northern forms reached the South of England, the conditions in and around the mountainous districts were such that few animals could remain there, as most of the valleys and plains had become buried under ice and snow, and they would have to seek feeding grounds outside these areas. It is to this period that we must assign the remains of the mammoth and rhinoceros which are so abundantly found on the old land surfaces on the north of the Thames, usually hidden under great thicknesses of drift, as in Endsleigh Street, and in other places in Middlesex. Here, and in some areas further south, they could have lived during most of the glacial period until at last driven away, when the valleys and plains became covered with vast sheets of water, due in part probably to subsidence, but largely owing to the gradual melting of the ice and snow further north. Whether the mammoth and rhinoceros continued to live much longer in some parts of the South and Southwest of England there is very little evidence at present to show. The supposition, however, held by some that they returned to the glaciated areas after the glacial period had passed away does not seem to me in any way probable, for hitherto their remains have only been found either under or in the drift, and not above it excepting when they have been washed out from the earlier deposits.

SUMMARY.

The evidence which has been obtained from ossiferous caverns at high elevations in the glaciated areas shows conclusively that the remains of the extinct mammalia found in them must have been introduced before any of the glacial deposits now in or upon them could have been laid down, therefore either before or so early in the glacial period that there could not have been at the time any considerable amount of snow on the neighboring mountains or glaciers even in the higher valleys.

From caverns in glaciated areas in North and South Wales, where paleolithic implements have been found in association with remains of the extinct mammalia, facts have been obtained which make it certain that the implements were those of man living at the same period as the extinct animals in those areas, and therefore of pre-glacial age. It has also been shown that as the cold increased, the higher valleys became filled with glaciers, and the caverns became uninhabitable. That afterward, as the snow line and glaciers descended lower and lower, some of the caverns were subject to inundations, which not only disturbed and rearranged the deposits previously in them, but wholly or partially filled them up with local materials. That in the Vale of Clwyd, North Wales, the local glaciers gradually coalesced with those from the western and northern areas, and a mixed material was distributed over the district to a height of over 600 feet, burying the ossiferous caverns beneath it. During this time also water re-entered some of the caverns, redisturbing in part the earlier contents and depositing some of the mixed drift over that previously in the caverns.

While these caverns were occupied as dens by the hyenas, northern and southern animals commingled in the valleys and on the great plains reaching out from them to the area now covered by the Irish Sea.

From numerous examinations made of undisturbed glacial deposits in Wales, the North of England and Scotland, it has also been proved very clearly that the extinct mammalia, whose remains are found in association with the implements of paleolithic man in caverns, must have lived there before those deposits had been laid down, as their remains always occur at the base or in the lower parts of the drift, and never above it. Further, there is not a particle of evidence to show that the extinct mammalia ever revisited those areas after the close of the glacial period.

A GUANCH CENOBY ON GRAN CANARIA ISLAND.

THE Guanches were a Berber tribe that formerly inhabited the Canary Islands, and it is said that something of their language is still heard in the rural districts, although it has been almost entirely superseded by the Spanish. They had many peculiar customs, among which may be counted their manner of disposing of their dead—the bodies were placed in caves and arranged in standing position around the walls—and others that were closely associated with the cenoby, of which we publish an engraving to-day. It is situated, like an eagle's nest, on a high and steep mountain in the district of Gufa, on the island of Gran Canaria, and consists of more than five hundred cells, which extend in all directions without any uniformity whatever, some being large and some small, some isolated and others communicating. These excavations were formerly hidden by a vertical wall which has since fallen away. The arch that formed the entrance was nearly 100 feet wide by about 85 feet high, and decreased toward the interior. The sun could easily penetrate all the cells used as dormitories. It is said that they were inhabited by the flarimaguadas, women who lived in retirement and led a pure and exemplary life. Their special charge was the care of the daily libations, offerings of milk and oil to their god. These vestal virgins of the Canary Islands enjoyed many privileges and their residence was considered a sanctuary, where pardon was extended to malefactors who took refuge there. They lived by alms received from the people.

In time of drought an appeal was made to the faicán (high priest), who then tried to appease the divine wrath by ordering a general procession, which consisted of the faicán accompanied by the king, the nobility and the people, who carried palms, branches and rods in their hands. These approached the dwelling of the flarimaguadas, who issued forth to meet them bearing vessels containing milk. Then all together went to Mount Tirma and climbed to the summit, where they poured out the milk and oil with certain ceremonies, including dancing and chanting of sad songs. After this they descended the mountain and went to the sea, the surface of which they whipped with their palms, branches and rods, at the same time uttering ferocious cries.

The Guanches had a written, as well as a spoken language, in which they used alphabetic and hieroglyphic characters. We are indebted to La Ilustracion Española y Americana for the cut and for the article.

CLIFF DWELLINGS ON THE CANARY ISLAND—FIVE HUNDRED CELLS USED BY FEMALE RECLUSES.

NATURE'S COMPASSES.

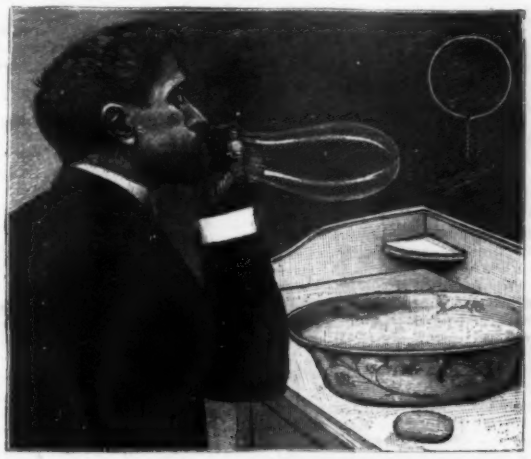
THE many different methods to determine the cardinal points while on the mountains, in both heavy timber and small bush, or upon the featureless expanse of a great marsh, are exceedingly numerous and reliable enough for all practical purposes during an everyday life in the bush, unless a very long journey is to be made, which would require a number of days, and would make it necessary to hold on a very fine point while making so long a distance. We will, says a correspondent in Forest and Stream, first take notes on the coniferous trees, pines, firs, spruce, cedars and hemlocks. The bark of these is always lighter in color, harder and drier on the south side of the tree; while it is in color much darker, is also damper, and often covered with mould and moss on the north side. The gum that oozes out from wounds and knot holes is usually hard and often of beautiful amber color on the south side, while on the northern side it remains sticky longer and gets covered with insects and dirt, seldom drying out to more than a dirty gray in color. On large trees that have rough bark, especially during the fall and winter months, the nests and webs of insects will always be found in the crevices on the south side. A preponderance of the large branches will also be found on the warmest or southern side of the trees. Also, the needles of all of the above mentioned trees are shorter, drier and of a yellowish green on the southern side, while they will be found longer, more slender and pliable, damper to the touch and darker green in color on the north side. The cedars and hemlocks, as if trying to outdo the others, always bend their slender tops of new growth toward a southern sky. The hardwood trees are equally as communicative, and have all the characteristics, so far as regards their trunks, of the coniferous trees, except the absence of gums; but this is more than made up by the fungous growth of mould and mosses that is very noticeable on the north side of these trees.

The ledges of rocks, which may be part of stupendous mountains, or merely an occasional cropping out here and there in the woods, or, perhaps, some great bowlder alone by itself, a silent witness of the glacial period, all alike testify to the effect of light and shade. The sunny side will usually be bare or at most only boast of a thin growth of harsh, dry kinds of mosses, that will only grow when having the light; while the northern sides will be found damp and mouldy, and often covered with a luxuriant growth of soft, damp mosses that love the shade, while every crevice will bear aloft beautiful and gracefully waving ferns. The forest floor on the sunny side of hills, ridges, clumps of trees, bushes and big rocks, is more noisy under the footfall than on the northern side of such places, where the dead leaves and litter are soft and damp, holding more moisture than in places exposed to the light of the sun. In an open country nearly void of timber clumps of small bushes during summer will furnish all the conditions found to exist among the leaves of the trees, being equally sensitive to light and shade as are the monarchs of the woods. The landscape green, with moving grasses and beautiful to the eye, which feasts on the countless numbers of wild flowers, representing every form and hue known in the flowery kingdom, also furnishes a reliable guide for locating the cardinal points, as most wild flowers, especially

the long stemmed varieties, hide their faces from the north wind, like the sunflower, turn toward a southern sky. Large bowlders, clumps of small bushes, mounds and small hummocks all testify, too, for the ground around such places exposed to the sun will be burned nearly bare of vegetation or parched up until of a dead grass color; while on the shady side it will be found quite green, and often here there are growing mosses and ferns of rare beauty, which thrive only in such places as offer them a combination of both moisture and shade.

FANTASTIC SOAP BUBBLES.

FOR the production of soap bubbles a clay pipe is ordinarily employed. But, by this method, only bubbles of the size of one's fist can be produced. In order



FANTASTIC SOAP BUBBLES.

to form larger bubbles, of about the size of a man's head, other means must be employed, as, for example, a wire ring, which anyone can readily make for himself. Select a piece of iron or other metallic wire, not too thin, wind it around a champagne bottle and twist the ends tightly together. Such a ring is pictured in the upper right hand corner of our illustration. The next step of importance is the preparation of a solution of soap and water. This solution must, above all, be sufficiently saturated, and, in order to attain this, a little sugar or glycerin is added.

Dip the ring now into the solution, remove it carefully, hold it perpendicularly before the mouth and blow steadily, but not too violently, toward the center of the ring; a bag-shaped bubble will be formed, which, after a short time, will release itself from the ring and float away, shining in the most vivid colors of the rainbow.

Large soap bubbles can also be produced by means of the hand. Dip the closed hand (fist) in the soapy solution, form a ring by means of the forefinger and thumb, and then blow from the opposite side, as indicated in our illustration.—Illustrirte Welt.

THE MYSTERIOUS BOX.

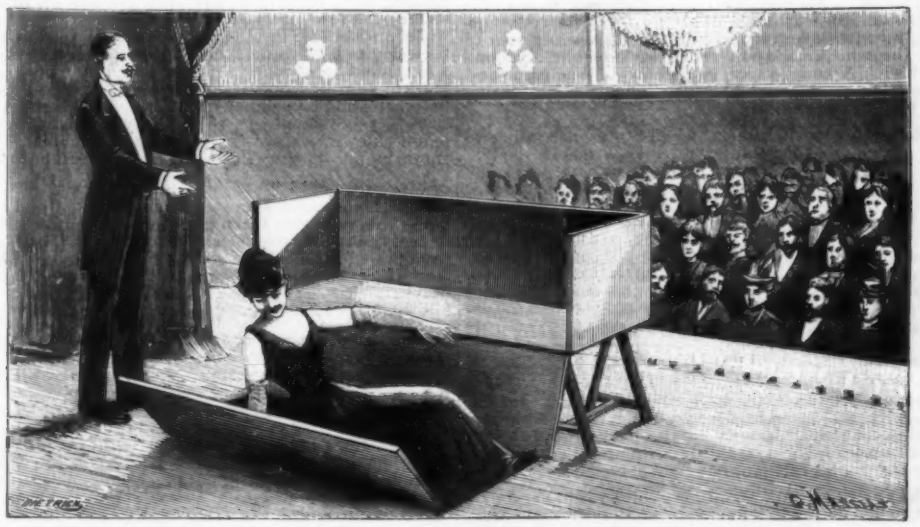
"LADIES and gentlemen, had Torricelli known the experiment that I am going to present to you, he would have seen therein a confirmation of his assertion that Nature abhors a vacuum!

"Ladies and gentlemen, when the famous wooden horse was introduced into Troy with its load of warriors, if the Trojans had conceived the idea of examining the interior thereof, they would have perceived the contents, and history would not have had to record the taking of that city. Nevertheless, some historians (I shall not name them, for fear of exhibiting too much erudition in this place)—some historians, I say, tell us that the horse was visited at the octroi of the city (for there was an octroi there, with inquisitors all dressed in green), and that its contents passed unobserved. At first sight, this seems impossible, and yet nothing is simpler for a person up in prestidigitation than to prove that an object such as a box, trunk or wooden horse is empty while it is really full."

Such was the set speech with which the illusionist who presented it introduced the following experiment.

To the middle of the stage were brought two trestles, and then a board, six feet in length and two and one-half in width, which was placed upon them. Four boards were then exhibited on both sides to the spectators, and afterward fixed to the horizontal board by hinges. These boards, when raised vertically by the operator and his assistants, formed an absolutely empty box.

"Here is a box that you judge is absolutely empty, because you have seen it constructed before your eyes. Well, you are mistaken; this box is not empty, for it contains something or somebody. Please look again!"



THE MYSTERIOUS BOX.

At this moment the boards were turned down and then raised again.

"You saw, did you not? How? No! But perhaps you did not look sharp!"

One of the assistants then turns down the board in front, when there is observed in the interior a woman dressed in a fancy costume wholly white, which, as in the serpentine dance, changes color and passes through all the tints of the rainbow.

This effect, incomprehensible in appearance, is easily produced as follows: We have said that the boards turned down. When they are lowered, in order to show that the box is empty, the one at the back is raised last.

While the assistants are occupied with the three other sides, a trap opens in the floor of the stage behind the trestles, and the woman who is to appear fastens herself to the back board, which, in rising, introduces her into the box.

When the board in front opens definitely, a projector placed in the prompter's box sends colored rays upon her gown, which thus changes tints and gives the apparition a fantastic and charming appearance.—La Nature.

THE LONGEVITY OF GERMS IN DUST.

IN a recent number of the Annales de Micrographie, Dr. Miquel gives the results of some interesting observations made by him in respect of the vitality of disease germs. In May, 1881, he took some earth from the Montsouris Park at a depth of 10 inches below the turf. This he dried for two days at a temperature of 30 deg. Cent., and then he placed the dust in hermetically sealed tubes, which he put aside in a dark corner of the laboratory. When taken the soil contained an average of six and a half million bacteria per gramme. After desiccation the number had fallen to rather less than four million. Sixteen years later, that is to say, last year, he still found three and a half million per gramme, and he was enabled to isolate the specific microbe of tetanus. The inoculation of this soil in guinea pigs determined death from tetanus after an incubation period of two days, showing the remarkable vitality of pathogenic microbes under favorable conditions.

ANTARCTIC EXPLORATION.

THE subject of exploration in the South Polar region is revived at the present time by a report which should have been presented some weeks ago to the convention of American naturalists in Ithaca, but, having been delayed, has just made its appearance in Science. A committee, of which Angelo Heilprin, of Philadelphia, is chairman, was appointed two years ago to consider both the practicability and the feasibility of exploring the Antarctic continent. At that time there was a great deal of talk in England and Germany about the same thing, scientific men the world over recognizing that the region in question is by far the largest in the world which is still an unknown territory, and also that our knowledge in regard to it has practically made no headway for more than half a century.

The movement in England looking to the organization of an expedition in 1896 came to nothing, and the promoters of it (who were mostly identified with the Royal Geographical Society) received a quiet hint that the government would not favorably regard an appeal for Parliamentary aid. And the matter has been dropped for the present.

German geographers, zoologists, geologists and botanists also evinced much enthusiasm on the subject in 1896; and a very elaborate plan for an invasion of a new region, directly south of the middle of the Indian Ocean, with two vessels, was formed. This enterprise likewise failed, although during the early part of the past winter it was taken up afresh by Profs. Thun, Virchow, Neumayer and Waldeyer, and the Emperor is to be petitioned with a view to securing his co-operation.

Dr. Frederick A. Cook, of this country, who accompanied Peary on one of his earlier voyages to Greenland, tried to organize an expedition to the Antarctic region in 1896; and simultaneously a number of Belgians were talking of a similar undertaking. The Belgian project was deferred a year, and in the mean time the commander, Lieutenant Adrian de Gerlache, of the Belgian navy, invited the American to join him. The invitation was accepted, and Dr. Cook's independent scheme was therefore abandoned.

After stopping at Rio Janeiro and Punta Arenas (on the Straits of Magellan) for coal, Gerlache's steam whaler, the "Belgica," was to start for Graham Land, six hundred or seven hundred miles southeast of Cape Horn, and just south of the South Shetland Islands, which are much frequented by whaling craft from Scotland and Norway. Americans, too, went there before the discovery of petroleum spoiled the whaling industry. It was the intention of Lieutenant de Gerlache to reach Graham Land early last December at the opening of what is the summer season, skirt the eastern coast of that island or peninsula (whichever it may be), get as far to the southward as possible during warm weather, and then establish a winter headquarters in March, while the "Belgica" steams away to Australia for coal and other supplies, to be gone six or eight months. The other projects of this party need not be recited here. It is sufficient to say that the Belgians are the only people who are now actually engaged in what is primarily a scientific exploration of the Antarctic region—a very limited part of that region, too.

A large part of Prof. Heilprin's report is devoted to a consideration of the possibility of making satisfactory arrangements with various whaling fleets. Direct information from the Australian whalers has not been obtained, but discouraging advice in regard to them was received by the committee from the late Baron von Muller. Peary was consulted on a number of questions, more especially in regard to estimates made by H. J. Bull, of Christiania, Norway, intended to cover one or more enterprises which should be both commercial and scientific, and which, it is alleged, might be made to return a pecuniary profit to the backers.

"Mr. Bull," says the report, "is virtually the organizer of the cruise of the 'Antarctic' in the years 1894–95, when a landing was effected on the assumed Antarctic continent at Cape Adare, and his opinions and estimates are deserving of respectful consideration. He confidently assumes that a joint commercial and scientific expedition could be arranged so as to render its outcome largely profitable to investors, even to the extent of £500 or more, and yet so directed as to place it mainly to the purposes of scientific investigation. In his various estimates, however, which cover the purchase of one or more suitable steamers, the absolute hiring of full officers and crews, the amount of capital required is so large, £9,000 to £14,000, as to render an association in this form of combined enterprise doubtfully desirable."

It may be remarked in passing that some of the English enthusiasts on this subject were negotiating in 1896 with another Norwegian for a similar purpose, but eventually dropped the matter.

Prof. Heilprin is not favorably disposed toward Mr. Bull's proposition. He believes that with the same amount of money (say $40,000 or $50,000) an entirely independent and purely American expedition could be fitted up. He regards this as much preferable, although he recognizes the difficulty of raising the money. He says, in closing:

"It seems probable that a selected number of scientific associations and institutions of general learning, such as universities and colleges, might be induced to co-operate to a common end, sending representatives with the expedition proportional to amounts of cash subscriptions. Your committee, if so desired, will be pleased to still further prosecute their inquiry."

M. P. Yvon states that absolute alcohol can easily be prepared from ordinary spirits by adding calcium carbide to the latter. The carbide decomposes any water present, generating acetylene gas in the process. The process is best conducted by placing the alcohol, which should contain more than 10 per cent. of water, in a flask with a quarter its weight of coarsely powdered calcium carbide. A vigorous generation of the gas will take place at first, but afterward this will become less rapid, and the flask should then be shaken at intervals, for two or three hours, after which it should be left at rest for twelve hours. The absolute spirit can then be distilled.

ENGINEERING NOTES.

The Belgian state railways will provide next summer in the trains between Brussels and Ostend so-called working or business cars, in which business men, lawyers, reporters, etc., will find every convenience for doing work while traveling.—Uhland's Wochenschrift.

The number of vessels which passed through the Suez Canal during the twelve months ending December 31 last was 3,986, as compared with 3,409 in 1896 and 3,434 in 1895. The receipts show a corresponding falling off —having amounted to 72,836,830 fr. in 1897, as compared with 79,569,994 fr. in 1896, and 78,103,718 in 1895.

The Duquesne steel works of the Carnegie Steel Company have in a single day produced 304 "heats" in twenty-four hours, and 1,928 tons of ingot steel in the converting and 1,700 tons in the finishing mill. This is said to exceed anything reported previously in the United States and to be vastly in excess of anything known in Europe.

An experiment in coaling the new battleships at Portsmouth, using their own crews only, was not very successful. Though the "Mars" shipped its full complement of 1,060 tons in nine hours and the "Prince George" its 650 tons in six, the "Majestic" took twelve hours to put in 873 of the 1,020 tons it required, and the "Resolution" eleven hours for 700 tons out of 1,295 needed.

A government board has finally rejected the celebrated "multicharge gun," which has been in process of testing for so many years. The principle of this gun depended on the successive discharge of a number of "pockets" of explosives along the course of the projectile from breech to muzzle, thus continually accelerating its speed. But now, according to the experts, smokeless powder produces the same effect more simply. Says The American Machinist: "On testing the 8-inch Haskell multicharge gun in February last, by the Board of Ordnance and Fortification of the War Department, only two rounds were fired, and at the second round the metal between the forward pocket and the bore was found to have been crushed in; this rendered the gun unserviceable. The board has declined to make a recommendation for any further expenditure on multicharge guns, believing, as it does, that smokeless powder has in a great measure obviated the necessity for the multicharge gun."

In the manufacture of all wide belts the best leather is taken from the center part of well grown ox hides, Mr. John Tullis stated in a paper on "Belt Driving," read before the West of Scotland Technical College Society, on January 29. Only one strap, of breadth over 8 inches wide, ought to be taken from each hide; the portion covering the spine of the ox should run down the center of each strap. The hide is always somewhat thinner along the line of the spine than it is toward the rib; so that a belt made as described is slightly concave, which form causes the belt to fit the convexity of the pulley. All stretch should be removed from the straps in process of currying. This method produces a belt that will run perfectly straight, stretching little or none, while it will hug a well made pulley closely, and at the same time develop with comfort its full working power. A safe working tension for double belting, ¾ inch thick, is 80 lb. per inch of width; and a safe working tension for single belting, ⅝ inch thick, is 50 lb. per inch of width. Thicker leather will stand a little more, while thinner leather will stand less.

The extent to which power transmission ropes stretch is a point on which there is little information available, and yet it is important to know what allowance to make in the case of ropes that are tightened by a tension carriage, for the splicing or undoing of a splice is an operation that involves no little time and trouble. A writer in The American Machinist of January 20 gives the result of his observation and experience, which is really not very much, although he is evidently connected with the manufacture of ropes. He says that manila rope usually stretches about 5 or 6 per cent. during its life, where it is not overloaded. There is no data available to ascertain the amount of stretch in the first and second week or month, but, speaking generally, in the course of a couple of months the rope ceases to stretch rapidly, and thereafter the stretch is very slow and quite regular. Transmission rope that is protected from rain is but little affected, but all rope is subject to slight extension and contraction from the hygrometric changes in the atmosphere. The kind called "Stevedore" rope is treated with a waterproof lubricant which reduces the effect of the weather to quite a small amount, but the amount has not been definitely measured. If the rope runs where rain gets upon it, then a tension pulley must always be used, as the extension and contraction of the rope is so great that no other method will take care of the slack.

The Russian government has adopted strong measures to protect domestic shipping. At present coastwise shipping between Russian ports situated upon the same sea must be done by Russian ships. From January 1, 1900, on, all shipping between Russan ports, whether on the same sea or on different seas, will have to be intrusted to Russian ships. An exception may possibly be made in regard to the shipping of salt from the Black Sea or Azof Sea to the Baltic. Furthermore, all sailors aboard Russian ships will have to be of Russian nationality. The government has expended considerable sums on the improvement of harbors and waterways. From 1885 to 1895, about $25,000,000 have been spent for harbor improvements at Odessa, St. Petersburg, Reval, Batum and other localities. Up to 1885, $4,500,000 had been expended for harbor improvement at Odessa, $6,500,000 for the St. Petersburg Canal, and $3,000,000 for work at other sea ports. The following table shows the increase of steamers in the Russian merchant marine:

	Domestic built. Number.	Domestic built. Tonnage.	Foreign built. Number.	Foreign built. Tonnage.
1884	22	3,041	262	69,480
1893	49	5,476	337	115,307

1896: Total, 341 steamers, of an aggregate tonnage of 129,546, and 1,638 sailing vessels, of 147,140 tons.

On the Caspian Sea there were 181 steamers and 507 sailing vessels under the Russian flag, with an aggregate tonnage of 253,000.—Uhland's Wochenschrift.

MISCELLANEOUS NOTES.

The annual production of paper in the world is now 2,200,000 tons; in 1850 it was only 221,000 tons. In France the production has risen from 40,000 tons in 1857 to 350,000 in 1897.—Cosmos.

In France a bill has been introduced which provides that twenty-five cycling companies are to be added to the cavalry and the army in general, the twenty-five companies comprising in total 3,634 men and officers. The wheel used is the Gérard model folding bicycle.—Stahl und Eisen.

According to Uhland's Wochenschrift, the English post office authorities intend to use motor carriages for conveying parcels. One carriage is already in use on the line, London-Brighton-Redhill, about forty-eight miles. The round trip, including stoppages for delivering the mail, takes six hours and fifteen minutes. The expenses for fuel are said to be about three and one-half cents per mile.

A Russian prince who is fond of Verdi's music has spent $6,000 to enable himself to hear "Rigoletto" whenever he pleases in his palace at St. Petersburg. The opera is acted by life-sized puppets whose acting is regulated by machinery, and the singing is done by phonograph. The owner has secured phonographic reproductions of the principal parts as sung by the principal artists of Europe, and changes his cast to suit himself. After putting the cylinders in place the owner presses a button and the opera proceeds automatically, so says L'Indépendance Belge.

Speed is the order of the day. A Delaware paper manufacturing firm recently demonstrated that a sheet of paper can be made from a standing tree in the space of two hours. In a forest near the mill three trees were felled at 7:45 and carried to the manufactory, where they were cut into pieces twelve inches in length, these being at once decorticated and split, and, thus prepared, the material was raised by an elevator to the five defibrators of the works. The wood pulp produced by these machines was then put into a vat, where it was mixed with the necessary chemicals, and, this process finished, the liquid pulp was sent to the paper machine. At 9:44 in the morning the first sheet of paper was finished, the entire manufacture having consumed two hours, lacking one minute.

In an article on "Generals" in "Die Zahl im Kriege," Capt. Berndt, of the staff of the Austrian army, gives a list of what he considers the greatest warriors the world has known—Alexander, Hannibal, Cæsar, Gustavus Adolphus, Turenne, Prince Eugene, Frederick the Great and Napoleon. Of these, three were over thirty and six were under that age when their first victories were won. On the other hand, since Napoleon's day there have been three generals of remarkable eminence, Suwaroff, Radetski and Von Moltke, whose first successes were achieved at the mature age of fifty-five, eighty-two and sixty-six. The most celebrated cavalry generals achieved success as young men, e. g., Murat, 34; Seydlitz, 31, at Rosbach; Sheridan, 32, and Stuart, the famous Confederate cavalry leader, fell at 30. Bonaparte, when besieging Milan, to a lady who asked him his age, answered: "Madame, aujourd'hui j'ai vingt-six ans, mais demain j'aurai Milan."—Army and Navy Journal.

After successful tests the Prussian state railways are going to adopt a mixture of acetylene and of oil gas for the illumination of railway cars. The proportion one to three has proved safe in the experiments of Gerdes, and the addition of one-third of acetylene had a marked influence upon the illuminating power of the gas. It is, therefore, proposed to adhere to that proportion for the present. The novelty will not involve any change in the gasholders or burners; only the reflectors will have to be replaced. The experiment is, hence, not risky. The town of Totis, in Hungary, is said to be satisfied with its acetylene lamps in streets and houses. An acetylene exhibition was planned for Cannstadt, but it took place in the two weeks beginning with March 6, in Berlin, under the auspices of the German Association for Acetylene and Calcium Carbide. A congress or conference of scientists and practical men interested in these industries met during the time of the exhibition.

The corn crop in the principal States, according to the Agricultural Bureau figures, compares as follows:

	1897. Bushels.	1896. Bushels.	1895. Bushels.
Ohio	92,000,000	124,000,000	93,000,000
Michigan	31,000,000	40,000,000	34,000,000
Indiana	110,000,000	133,000,000	121,000,000
Illinois	233,000,000	285,000,000	255,000,000
Kansas	162,000,000	248,000,000	205,000,000
Missouri	172,000,000	177,000,000	238,000,000
Iowa	220,000,000	322,000,000	299,000,000
Nebraska	241,000,000	299,000,000	127,000,000
Total eight States	1,261,000,000	1,638,000,000	1,372,000,000
" United States	1,903,000,000	2,208,000,000	1,372,000,000

Nebraska produced the most corn last year. Iowa is generally the largest corn producer, with Illinois a good second and formerly in the lead. Seven of the above States raised two-thirds of the total crop. New England States raised only 6,000,000 bushels.

The cyclist corps of about 1,000 soldiers did very good service at the great maneuvers of the German army last autumn. The Jahrbucher für die Deutsche Armee und Marine points out that the cyclists acquitted themselves well in conveying dispatches and orders, in doing scout and patrol duty, alone or in conjunction with cavalry; in occupying and holding exposed spots, bridges, etc., until the reinforcements arrived; and in covering artillery and baggage and even cavalry. As regards the first point, General Haseler dispatched cyclists in all directions on one Sunday night, when it had been raining all day, and the orders to advance were received in good time, although most of the messengers had been doing sixty miles every day all the week on very bad ground, roads or no roads. When the Emperor was driving to the field in a carriage drawn by four horses from the Czar's studs, nobody could keep pace but his special cyclists. After prolonged rains, the men on the wheel had indeed to stick to the roads; in other respects they outdid the men on horseback in swiftness and endurance.

SELECTED FORMULÆ.

Embalming Fluid.—

1. Solution zinc chloride (U. S. P.)	1 gallon.
Solution sodium chloride, 6 ounces to pint	6 pints.
Solution mercury bichloride, 1 ounce to pint	4 "
Alcohol	4 "
Carbolic acid (pure)	8 ounces.
Glycerine	24 fl. oz.

Mix the glycerine and carbolic acid, then all the other ingredients, when a clear solution of three gallons results, which is the proper amount for a body weighing 150 pounds.

2. Arsenious acid	100 gm.
Sodium hydrate	50 "
Carbolic acid and water, of each a sufficient quantity.	

Dissolve the arsenious acid and the soda in 140 c. c. of water by the aid of heat. When the solution is cold, drop carbolic acid into it until it becomes opalescent, and finally add water until the finished product measures 700 c. c.

3. Salicylic acid	4 drachms.
Boric acid	5 "
Potassium carbonate	1 "
Oil of cinnamon	3 "
Oil of cloves	3 "
Glycerine	5 ounces.
Alcohol	12 "
Hot water	12 "

Dissolve the first three ingredients in the water and glycerine, the oils in the alcohol, and mix the solutions.

4. Thymol	15 grains.
Alcohol	½ ounce.
Glycerine	10 "
Water	5 "

Success in the use of any embalming fluid depends largely on manipulation, an important part of the process being the thorough removal of fluid from the circulatory system before undertaking the injection of the embalming liquid.—Bulletin of Pharmacy.

Asbestos Furnace Covers.—H. Jervis describes how an extremely light furnace cover may be constructed from asbestos millboard. A piece of the millboard—10 inches by 4 inches by ⅜ inch—is perforated in about a dozen or more places with glycerined cork borers, then nicked about an inch from each short end and immersed in water until saturated; next bend the board from the nicks at right angles and shape the perforated portion by bending it over a bottle with as little force as possible. The result should be a perforated arched tunnel, resting on narrow horizontal ledges at each side. Dry this cover in the furnace, after setting it in position and pressing it well to the supports. Three such covers, weighing one pound, replaced twenty-four fire clay tiles, weighing thirteen pounds, and a higher temperature was obtained than with the latter. A simple method of constructing a combustion furnace for use with asbestos covers, from a single sheet of mild steel, 5 feet long and about ⅛ inch thick, is described in the same illustrated article, while some further uses of asbestos in the laboratory are also referred to.—Chem. News, lxxvii, 5.

Splitting Selenite Plates.—After securing a good flat piece of selenite of the required size, say ¾ inch square, and splitting it with a thin blade down to say ⅛ inch in thickness, which is comparatively easy to do, cement one side of the plate to a glass slip, using any convenient cement. Ordinary glue will answer, or even mucilage—anything, in fact, that will hold the plate firmly. Then, using the same thin blade, carefully detach layers of the plate, one after another, until you get the plate attached to the glass nearly thin enough, making sure, each time, that you remove all of each stratum. Now put the slip into some liquid (warm water answers for most cements), and let remain until the selenite plate is detached. Handle very carefully, and cement to another slip the face that was uppermost in your first operation. Let dry, and proceed as before, testing occasionally with the Nicol prisms and some crystalline object to see if you have got the selenite down to a proper thickness or thinness. The thinner and sharper the blade, the easier the operation.—Nat. Drug.

Lead Explosions.—Many mechanics have had their patience sorely tried when pouring lead around a damp or wet joint to have it explode, blow out, or scatter from the effects of steam generated by heat of the lead. The whole trouble may be avoided by putting a piece of resin, the size of a man's thumb, into the ladle, and allowing it to melt before pouring.

Lacquer for Stoves and Other Articles to Withstand Heat.—Buchner, in the Bayerischen Industrie und Gewerbeblatt, gives a formula for a lacquer which is not altered by heat, and which does not give out disagreeable odors on heating: Thin 1 part of sodium water glass with 2 parts of water in order to make the vehicle. This is to be thickened with the following materials in order to get the desired color: White, barium sulphate or white lead; yellow, baryta chromate, ocher or uranium yellow; green, chromium oxide or ultramarine green; brown, cadmium oxide, manganese oxide or sienna brown; red, either iron or chrome red. The coloring materials must be free from lumps, and well ground in with the vehicle. Bronze powders may also be used either alone or mixed with other coloring stuffs, but care must be taken, in either instance, to secure a sufficient quantity. The colors should be made up as wanted, and no more than can conveniently be applied at the time should be prepared. An excellent way to use the bronze powders is to lay on the coloring matter, and then dust on the powder before the glass sets. Lines or ornamentation of any sort may be put on by allowing the coating of enamel to dry, and then drawing the lines or any desired design with a fresh solution of the water glass colored to suit the taste, or dusted over with bronze. The editor of the National Druggist can testify to the excellence of this enamel, which is, however, not quite a novelty, as water glass solutions have been used for the purposes indicated for many years.

REDUCTION IN COST OF STEAM POWER FROM 1870 to 1897.*

By F. W. DEAN, Boston, Mass.

IN the year 1870 the most economical steam engine in use in mills was the Corliss simple condensing engine, which used 19 or 20 pounds of steam per horse power per hour. Previous to that time compound engines had been used in England in mill practice, and simple engines had in many cases been changed to compound. In this country compound pumping engines had been used to a very limited extent, notably the Worthington direct acting duplex compound, the first one of which was put in at the Charlestown, Mass., water works in 1863, and the installation of the Morris engine at Lowell and the Leavitt engine at Lynn are well known examples of them in the early part of the period which we are considering. The Lowell engine was of the Simpson type, so named from the Simpsons, of London, who originated the arrangement of two compound cylinders with different lengths of stroke under one end of a beam. It is known as the Morris engine from Henry G. Morris, the builder, but its design is due to the late Robert Briggs, of Philadelphia. The Pawtucket pumping engine, built by George H. Corliss, and started on June 30, 1878, is another important example of economical pumping engines, and probably was the most economical steam engine which had been built up to that time, having used less than 14 pounds of dry steam per indicated horse power per hour. While these engines are not mill engines, they influenced the practice of builders of mill engines, and can properly be considered with them. Pumping engines have heretofore been the leaders in economy, but at present the best pumping and mill engines are practically equally economical.

Of course the greatest single step in economy was the introduction of the compound engine. At the present time we may cite the Louisville pumping engine and several mill engines, one or more at Grosvenor Dale, Conn.; Natick, R. I.; West Boylston, Mass.; Berkley, R. I., and Lawrence, Mass., as being about on a par, and representing the best commercial economy. In 1873 the most economical compound engines used about 16½ pounds of steam per indicated horse power per hour, as shown by tests of the Lynn and Lawrence pumping engines, which then established new records for duty. Improvements in methods of using steam were made, until it is now as easy to design an engine to use less than 13 pounds of feed water per horse power per hour as it was to use as little as 16 pounds in 1875. At this date steam jackets were common, and were used in all engines which gave the most economical performances. The steps, however, that lowered the steam consumption of compound engines from 16 to 14 pounds per indicated horse power per hour were largely the introduction of a cut-off on the low pressure cylinder and a reheating receiver between the cylinders. Although the reheater was invented by the late E. A. Cowper, of London, in 1862, so far as I know it was first used in this country by E. D. Leavitt in his engines for the Calumet & Hecla Mining Company, and is regarded by him as one of the most important causes of the economy of his engines.

These features appear to have been the principal means of lowering economy to 14 pounds of steam; but to what are we to attribute the step to 13 pounds? Clearance is well known to be an important factor, and its reduction, especially in the last cylinder of a series, is important for economy. It is receiving constant attention from careful designers, and its reduction is a constant source of gain. The 13-pound mark has also been reached by an increase in steam pressure with resulting increase in the number of expansions. In some cases a reduction in the size of the high pressure cylinder has doubtless contributed toward economy, by means of which smaller surfaces are exposed to the boiler steam than would otherwise be the case. This carries with it a proportional reduction of initial condensation in the cylinder which is most prolific in this cause of waste. Still further, the 13-pound mark has, in general, been attained by engines which have a low pressure cylinder larger for the work to be done than is commonly the case, so that the mean effective pressure referred to the low pressure cylinder is in the vicinity of 21 pounds. There are occasional exceptions, as in the case of the Louisville engine, which worked with a mean effective pressure referred to the low pressure cylinder of 25 pounds. Such cases are exceptional, and their economy can be attributed to great perfection of detail.

It will in general be observed, however, whatever may be said of other causes, that most of the extreme cases of economy are those in which a good vacuum has been maintained. This leads me to say that the importance of good vacuums is often not appreciated, and that air pumps and condensers are as often too small.

There is a strong tendency nowadays to underrate steam jackets, but I believe that in every case where they have been wasteful, or where their economy is indifferent, at all events with ordinary speeds, an examination would show that the jackets are air bound, water logged, blowing through traps, or that the jacket piping is bare, and thus steam for heating the building is charged to the engine. Such an arrangement of pipes can furnish but indifferent material for giving up latent heat to the working fluid within the cylinders, and is, in fact, absurd.

The effect of reheaters in drying out steam which issues from a preceding cylinder and in superheating it to 60 or 90 degrees, as is often the case, for use in the next cylinder, cannot be otherwise than advantageous, for, as Prof. Thurston shows in his paper of 1894 before this society, heat so added to the working fluid saves much more steam than was condensed to liberate this heat. While these considerations are very general, they are necessarily so, for nobody can attribute to any one of the features named its proper effect. Moreover, their combinations are very varied. Whatever may be said pro and con on this subject, it cannot be denied that the best results have been obtained from engines equipped with jackets and reheaters.

Considering economies effected, it is safe to say that without including triple expansion engines steam economy has steadily decreased from 20 to 12½ pounds per indicated horse power between 1870 and 1897. This corresponds to a saving of 37½ per cent.

Within this period of 27 years the use of exhaust steam has extended in various mills, such as cotton, woolen and paper mills, so that in some mills the cost of steam power is next to nothing. Economies of this kind are not confined to the use of the exhaust of noncondensing engines, for since 1895 the writer's firm have had installed at the Washington Mills, Lawrence, Mass., a large surface condensing vertical compound engine, the rejected heat of which is utilized. In this mill large quantities of warm water are used in the dyehouse, which has heretofore been heated by exhaust and direct steam. Now the circulating water of the new engine is sent from the condenser to the dyehouse by the circulating pump at about the temperature required. In this case the rejected heat of the engine is just as effectively used up as it would be if the engine were noncondensing and sending its exhaust to the dyehouse. There are advantages, moreover, in the compound surface condensing engine, for there is less rejected heat to use, with consequent diminished chance for waste, and there is less heat lost by radiation from a pipe full of warm water than from one of full steam. This constitutes one of the latest forms of recent economies. It may be mentioned incidentally that by the surface condensing engine oil is kept out of the dyehouse and away from the cloth. The air pump discharge, being small in volume, and containing all of the cylinder oil, can be easily taken care of in any way which appears to be advantageous.

What is there to be said concerning boilers within the period that we are considering? The horizontal return tubular boiler is still the standard of the country, and will probably so remain. It is cheap, and if properly built it is safe. As its tube heating surface can be effectively blown with steam with the certainty that the jet will strike every part thereof, and as, furthermore, its tubes can be effectively scraped at any time without taking the boiler out of service, it must necessarily be more economical than any of the numerous water tube boilers which are now being introduced. The fire surfaces of the latter can only be indifferently blown, and they cannot be scraped at all unless the boiler is cooled down, and in general it cannot then be done with anything approaching thoroughness. There is scarcely any improvement to be noted in the horizontal return tubular boiler during the last twenty-seven years as far as economy is concerned, but I believe that grates have been improved to a measurable extent, resulting in an economy of perhaps 2 per cent. My own experience teaches me that the internally fired boiler, either of the locomotive or vertical type, will save under equal conditions some 7 per cent. of coal compared with the horizontal return tubular boiler, besides causing an important economy in doing away with brick work.

Bryan Donkin, in a recent paper before the Institution of Civil Engineers, in discussing boiler economies says: "Generally speaking, internally fired boilers give a higher efficiency than those externally fired. The old and well known locomotive type, with smoke tubes and induced draught, stands high as a very economical steam generator." Praise from so careful an investigator as Mr. Donkin should carry great weight.

Within 27 years economizers for heating feed water in smoke flues have become common. Although subject to a rather large depreciation, in the general case they will save about 7 or 8 per cent. of coal.

There are economies to be obtained from the use of vertical engines. These come from reduction of friction, reduction of repairs to cylinders and pistons and diminished cylinder oil consumption. It would not surprise me if there were a net saving of 5 per cent. by reduced friction of a vertical compound compared with a horizontal engine.

Summing up the various items that have been mentioned, the following may be presented as the economies of the period from 1870 to 1897:

	Per cent.
Saving due to compounding, jackets, reheaters, higher pressures and greater expansions	37
Due to vertical engines	5
Due to vertical internally fired boilers	7
Due to economizers	7
Due to improved grates	2

As these economies could not be simultaneously applied to the original condition of a mill, their sum is not a result that could have been realized in any case. With these important economies having been brought about during 27 years, the question arises, Are there any compensating disadvantages?

It is easy to show that there are not, for

1. The first cost of a cross compound condensing engine is no greater than that of a pair of simple condensing engines 27 years ago, on account of improved tools and processes and reduced prices of materials.

2. Interest charges are less than they were 27 years ago.

3. The depreciation of engines is less than it was 27 years ago, on account of better materials, better workmanship, better oil and better means of applying oil. Vertical engines will render the depreciation of cylinders, pistons, piston rods, piston rod packing and cross heads less than similar parts in horizontal engines.

4. The reduction in the number of boilers required by some 33 per cent. for a given power within 27 years carries with it many reduced charges, such as first cost, interest, repairs, depreciation, insurance, taxes, cost of boiler houses, cost of attendance, and various lesser items.

5. Present boiler building practice is superior to the old, so that high pressures are now as safely and comfortably carried as the lower pressures of 1870. Better materials, longer plates and fewer joints, butt joints of high efficiency and maintaining the circular form with changes in pressure, drilled holes, hydraulic riveting and round tool calking render it as safe to carry 200 pounds or more as any lower pressure.

6. I might include reductions in cost due to handling coal by conveyors for large plants and by mechanical stokers. Conveyors are in some cases very economical, but mechanical stokers are of doubtful value, speaking generally. The greatest efficiency of the conveyor is to be found in connection with the mechanical stoker.

So far the only steam engine considered is the compound engine. This engine has recently been found capable of utilizing the higher pressures much more economically than was formerly suspected. It has therefore diminished the advantage of the triple expansion engine to such an extent that the latter has met with something of a setback. I believe, however, that the triple engine is still to be common when pressures begin to exceed 160 pounds of steam, and its undoubted advantage at sea gives evidence that it will be no less on land. Within a year or two an interesting and instructive comparison can be made between two pumping engines, one compound and one triple, both to use 185 pounds of steam and designed on the same lines by Mr. Leavitt. It seems probable that the relative economies of the compound engine, using 160 pounds, and the triple, using 185 pounds of steam, are to-day represented in the very best practice by 12¼ pounds of steam and 11¼ pounds of steam respectively per indicated horse power per hour. This corresponds to a saving of 8·16 per cent., which is a paying saving.

Very careful attention should be paid to the kind of steam valves used in engine cylinders, for leaky valves can readily nullify the advantage which may be derived by anything which can be done to contribute to economy in the general design. It is the writer's experience that the gridiron valve, properly designed with ample lap, and originally made strictly tight by scraping, will remain so far longer than any other kind.

The future, so far as we can now see, offers us highly superheated steam for further means of economy. The technical papers have frequent accounts of the use of such steam in Germany, and published tests (see Engineering, pp. 113, 391, 1895) show that a small Schmidt "motor" has used 10·17 pounds of steam per indicated horse power per hour. It would seem that we have a right to anticipate in the early future a steam rate of 10 pounds by means of superheated steam in the best designed engines. Compared with the lowest rate thus far mentioned, this corresponds to a saving of 11·11 per cent.

We have also in anticipation the use of very high steam pressure and quadruple expansion engines as built experimentally at Cornell University and described by Prof. Thurston last year before this society. If, however, steam can be so highly superheated that expansion in one cylinder will not cause condensation or even the saturated condition until the time of exhaust, as was the case in the Schmidt motor, extreme economy may be obtained without resort to the multiple expansion engine.

The economies thus far mentioned relate to improvements in engines and boilers; but one of the greatest economies results from the low cost of coal at present in Lowell, Lawrence and similarly located towns.

The price of coal in these places has fallen from $7.10 per ton, in 1870, to $3.85 per ton, in 1895.

These prices show a saving from 1870 to 1895 by themselves of about 46 per cent.

I shall now consider the actual figures making up the cost of a mill steam plant and its cost of operating, say of 1,000 horse power, in most mill towns in the State of Massachusetts away from tidewater. The very best steam plant of this power 27 years ago, including a pair of simple condensing engines using 20 pounds of steam, boilers evaporating 8 pounds of water on total coal used, buildings, chimney and all accessories, cost $70 an indicated horse power. The fixed charges on such a plant were interest at 6 per cent., depreciation at 4 per cent., repairs at 2 per cent., insurance at 1 per cent., or a total of 13 per cent.

13 per cent. of $70 is	$9.10
Coal at 2·50 pounds per I. H. P. per hour, at $7.10 a ton	24.40
Attendance, boilers—3 day men at $1.50, 1 night man at $1.50	1.85
Attendance, engine—1 engineer at $3.00, 1 assistant at $2.00	1.54
Oil, waste and supplies	1.25
	$38.14

The very best plant of 1,000 horse power can be installed to-day complete, including buildings, chimney, compound engine using 12·5 pounds of steam, boilers evaporating 9 pounds of water on total coal used, economizers and all accessories for $57 per indicated horse power. Such a plant can run on 1·4 pounds of coal per indicated horse power per hour for total coal consumed. The fixed charges are: Interest at 5 per cent.; average depreciation, 3½ per cent.; repairs, 2 per cent.; insurance and tax, 1 per cent., or a total of 11½ per cent.

11½ per cent. of $57 is	$6.55
Coal at 1·4 pounds per I. H. P. per hour at $3.85 a ton	7.41
Attendance, boilers—2 day men at $1.50, 1 night man at $1.50	1.39
Attendance, engine—1 engineer at $3.50, 1 assistant at $2.00	1.69
Oil, waste and supplies	.80
	$17.84

Saving in 27 years in first cost, per cent.	18·6
Saving 27 years in operation, per cent	53·0

On the supposition that superheated steam can reduce the steam consumption to 10 pounds per indicated horse power per hour, and that the combined efficiency of boilers and economizers is not affected thereby, the cost of installation of 1 horse power can still be taken at $57.

The cost of coal per I. H. P. will be	$5.88
Other charges will be	10.43
Total	$16.31

This makes a saving of yearly charges, compared with the best present plant, of 8½ per cent.

Some actual costs of a yarn mill in Massachusetts built in 1889 are as follows:

Cost per horse power of engine (compound)	$60.50
Total coal burnt per year, tons	2,674
Average I. H. P. for the year	1,132
Total coal burnt for power, heating mill and banking fires, per I. H. P. per hour, pounds	1·75
During the six months when no heating was done the coal used per I. H. P. per hour was, pounds	1·65

* Paper presented at the New York meeting of the American Society of Mechanical Engineers.

The cost of operating a horse power per year was as follows, assuming 11½ per cent. fixed charges:

Total cost of plant, $66,600, at 11½ per cent.	$7,659.00
Coal, 2,674 tons, at $4.75 per ton	12,701.00
Attendance $8.85 a day × 308 days	2,735.80
Oil waste and supplies	312.00
Total cost of power	$23,397.80
Average horse power per year, I. H. P.	1,132
Cost per I. H. P. per year	$20.67
Cost corrected for coal used in heating mill	20.01

The following figures were given in The Engineering Record for March 14, 1896, for the Stevens linen mill, Webster, Mass. The engine is a compound, and was indicated morning and afternoon every working day throughout the year, and the coal is that used for all purposes throughout the year:

	1893.	1894.	1895.
Average I. H. P. for the year	381	393	396
H. P. hours for the year	1,042,231	803,792	1,076,134
Coal, pounds for the year	1,831,700	1,493,243	1,775,720
Average coal per I. H. P. per hour, pounds	1·76	1·67	1·65

THE IMPERIAL NAVY YARD AT KIEL.

VERY few tourists who visit Germany's naval city and its beautiful bay are willing to leave the vicinity without first inspecting at least one of the armored vessels anchored in the harbor, as well as the works where some of these colossi have been built. Of course, the duty of guarding technical secrets makes it impossible to grant too close an inspection of the workshops and storerooms, and closes many doors to the visitor, but what he sees and learns from the guide assigned to him at the entrance is sufficient to give him an idea of the extent of the navy yard, which is now one of the best equipped in Europe.

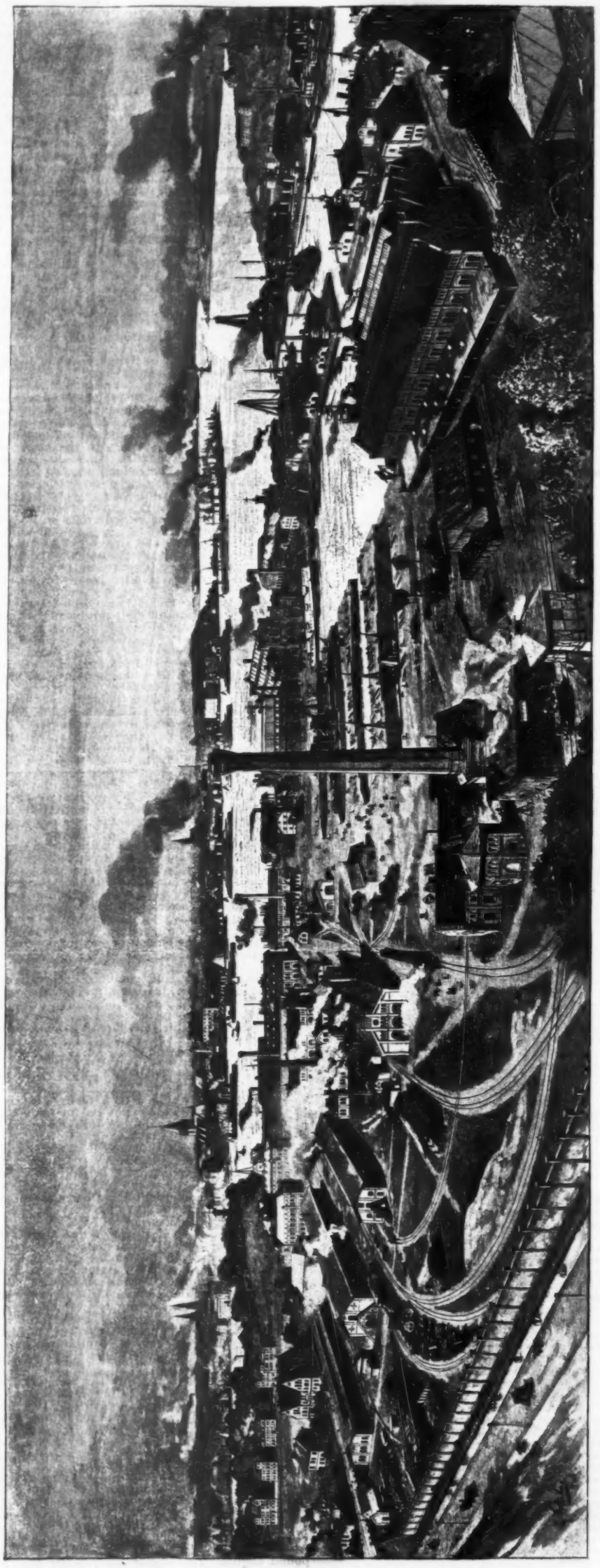
From a strategic point of view, however, its importance does not depend on the perfection of all its arrangements, but on its location, which is so sheltered that disabled vessels can always be repaired there and vessels that have been held in reserve can be provisioned, no matter how fierce a battle may be raging outside of the harbor; for the works are so far back from the strongly fortified entrance to the bay that neither the eye nor the shots of the enemy can reach them, and as long as the German army holds the land there will be communication with the interior of the country by rail. The importance of the navy yard at Kiel was greatly increased by the opening of the Kaiser Wilhelm Canal, for this will always enable vessels operating on the Elbe during a blockade to reach the docks for repairs or for a fresh supply of provisions or ammunition.

In order to prepare the shore opposite Kiel for use as a shipyard, extensive changes had to be made, such as leveling some hills and filling in places on the shore with the earth thus obtained. Many cubic yards of earth were removed, but a steep ledge still remains just across the road that runs along the outside of the wall around the navy yard and connects Gaarden and Ellerbek, and from this ledge the fine view reproduced in our engraving was taken.

Referring to the latter, we see, on the western shore of the harbor, the city of Kiel, which has grown very rapidly since it became the headquarters of naval affairs. In about the center of the city, embedded in the mass of houses, stands the church of St. Nicholas, the oldest and most beautiful house of God in the whole city, and to the left of this, close together, rise the spires of St. Jacobi and of the new Catholic church, while at the right, on a hill, is the beautiful new Gothic "Garrison Church." Close to the bank stands the royal palace, utterly bare of all architectural ornament and built on the foundation of the old "Wasserburg" of Graf Adolf IV., of Schauenburg, the conqueror of Bornhöven and founder of "tom Kil" (Kiel). It is now the residence of Prince-Admiral Henry, whose flag flies from the tower. A celebrated promenade begins at this palace and passes through Düsternbrook, ending near the imposing buildings of the Naval Academy at Bellevue. Beyond, the water spreads out into a wide bay, but contracts again to a narrow passage at the fortifications at Friedrichsort, and then joins the open sea.

After the conclusion of the naval maneuvers in the autumn the squadron entered the bay, and our engraving shows them arranged in a long chain extending from the inner end of the harbor to the bay, some of them under steam. The vessels farthest away from us, in the second line, are the high-masted cadet and school ships; in front of them, fourth class armored vessels of the "Siegfried" type, which are easily recognized by the shape of their hulls; next comes the "König Wilhelm" with its two smokestacks between the two military masts and the short signal mast, and against its long hull the sharp lines of the imperial yacht, the "Hohenzollern," stand out clearly. This side of the latter are three powerful men-of-war of the "Brandenburg" type, and two vessels of the old "Saxon" type end the line. Some of the vessels of the squadron are not in this line, as they have already entered the yard, which has an area of 130 acres, 96,000 square yards of which are covered with buildings which lie just at our feet, on this side of the harbor.

The entrance to the repair basin, between the coal yard and the gun and artillery storehouses, is 328 feet wide and is closed at night by having a chain stretched across it. Lying by the wharf of the coal yard we see the gigantic floating crane, capable of lifting 100 tons and propelled by its own power, and at the farther side of the basin, in the right hand corner of the picture, is the "Kurfürst Friedrich Wilhelm," distinguished by the admiral's pennant with the black cross. The basin is about 33 feet deep and is surrounded by so-called "ships' rooms," long sheds in which the supplies for the ships of the Baltic Sea squadron are kept. On this side of the basin, where we see the two smokestacks and masts of the dispatch boat "Blitz," is the chain testing station fitted up with a hydraulic chain testing machine of 200 tons and a torsion machine of 250 tons pulling power; and on the same shore, but at the opposite corner, the smaller floating crane, of 40 tons



THE IMPERIAL NAVY YARD AT KIEL.

capacity, rises above the roofs of the "ships' rooms," while on this side of the crane, by the quay, is the hull of the "Niobe," the good old school ship that has been roofed over and is now used as floating barracks.

The small dimensions of the basin call for care in manipulating heavy armored vessels, especially when one is to be turned so as to pass from the supply basin to the inner construction basin, which is of the same depth. On this side of the latter basin, besides the small store houses, the large buildings for the sail-makers' workshops and for the storage of masts and boats have been erected, while from the other side resound the noises of the main workshops, the boiler shops, the foundry and the machine shops. Along the shore, next to the main buildings, stand the shops in which the armor plates are made, and over their roofs we see the scaffolds of the slips. There are three such slips in the Imperial navy yard; they lie parallel and have a length of 383 feet 8 inches; the one used for the first first-class armored cruiser, "Fürst Bismarck," had to be lengthened considerably at the land end.

Vessels needing repairs pass directly from the construction basin into one of the four dry docks that lie side by side, and after the dock has received the ship and been shut off from the basin by means of pontoon gates, the water is pumped out by the apparatus in the pumping station, the high chimney of which is noticeable in the foreground of the picture, so that the entire hull is left free. Neither of the four available dry docks is large enough to accommodate such a vessel as the "Fürst Bismarck," and consequently the new dock now in process of construction became a necessity. To reach this dock we would have to pass from the pumping station between the buildings at the left, in which materials are stored and from the center of which the fire tower rises, to the chief administration buildings, from which the naval flag flies, leaving the navy yard by a gate which is watched day and night by the Berlin police, and behind the right wing of the administration building we would find the new dock, which is 574 feet long and 99 feet 3 inches broad, while the old docks vary in length from 328 feet to 393 feet 8 inches and in width from 62 feet 4 inches to 72 feet 2 inches. The new dock will be entered directly from the harbor. Wilhelmina Hill, which is now crowned by an observation tower, will be leveled and the earth used in building, and when that has been done all arrangements for the navy yard will have been completed.—Illustrirte Zeitung.

THE UNITED STATES BUYS THE "MAYFLOWER."

THE Navy Department of the United States has purchased the steam yacht "Mayflower," built last year for the late Ogden Goelet. The deal was consummated on March 16 and the boat was sent at once to the Brooklyn navy yard, where she will be overhauled and made suitable for war purposes. The price paid is said to be about $500,000. There is some doubt as to exactly the purpose she will be put, as it is said that she will be used as a torpedo boat destroyer; but she is hardly fast enough for this purpose, as she only made 16¾ knots per hour, but she is admirably adapted as a dispatch boat, and when she is overhauled she will be better for hostile service than the dispatch boat "Dolphin" and the little gunboat "Petrel" and the equal of the "Bancroft," designed as a practice ship for naval cadets. The "Mayflower" will join Admiral Sicard's fleet as a picket and dispatch boat as soon as she is refitted. The "Mayflower" has a coal capacity of 700 tons, which will enable her to have a large steaming radius. The yacht will be made ready for service within a month. Mounts for 6-inch rapid fire guns will be placed upon her, and her armament will include torpedo tubes and a number of rapid fire guns.

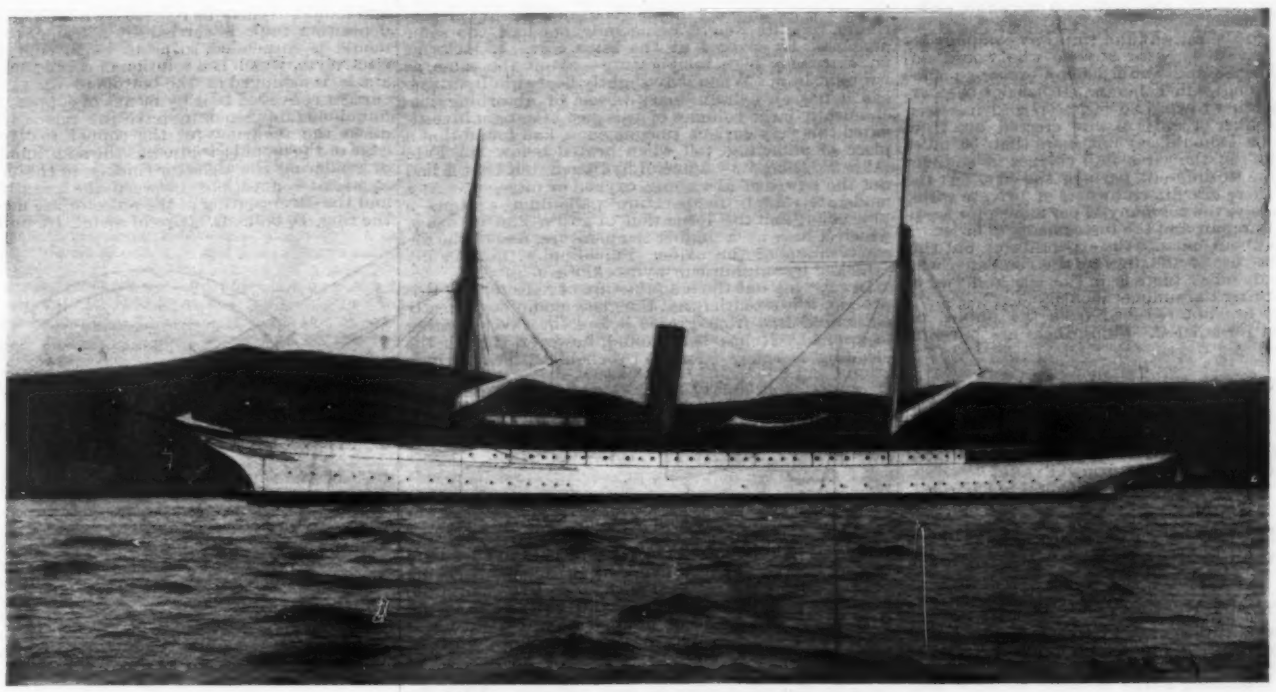
The "Mayflower" is a steel twin screw yacht of 1,806 tons. It is the eighth largest yacht in the world and was built from the design of Mr. George L. Watson, of Glasgow.

The "Mayflower" is built on the spar deck principle, with a well aft of the raised forecastle head and forward of the foremast, while the promenade deck extends from the foremast to within a few feet of her stern. It is rigged as a schooner, having two masts with fitted topmasts. She has a standing bowsprit and running jibboom. Her dimensions are as follows: Length on load water line, 275 feet; between perpendiculars, 288·8 feet; while the length from over the figurehead to the taffrail is 320 feet; the breadth is 36·7 feet; the depth of the hull is 17·7 feet. The net and gross tonnages are respectively 1008·89 tons and 1778·93 tons, with a tonnage of 1806 tons according to Thames yacht measurement, or 378 tons smaller than Mr. W. K. Vanderbilt's steam yacht "Valiant," which is the largest yacht in America.

The "Mayflower's" engines, which were supplied by the builders, consist of two sets of inverted triple expansion engines having eight cylinders, the diameters of which are 32½, 38 and 40 inches respectively, with a piston stroke of 27 inches. Steam is supplied by two double-ended return tubular boilers. The auxiliary engines on board are very numerous, including a refrigerating plant on the Kilbourn system. There is duplicate electric machinery, as well as a large battery of accumulators. Two powerful search lights are provided.

The "Mayflower" was launched at Clydebank, November 7, 1896. Her trial trips began on May 3, 1897, and on May 6 her official speed trial took place, the mean speed attained for several hours with continuous steaming being 16¾ knots per hour, equal to 19·288 statute miles per hour. The engines indicate 4,350 horse power.

In fitting up the yacht no expense was spared. The main saloon was finished in teak and mahogany, while the mural and ceiling decorations were the work of noted French artists. The library is supplied with 2,000 volumes, all of which are still on board. The smoking room was finished in mahogany and painted white. A feature which rather startled naval architects, when they knew about it, is the large reception hall, finished in rosewood, into which one steps from the companion ladder on boarding the yacht.



THE UNITED STATES STEAMER "MAYFLOWER."

There are twelve staterooms, a doctor's room and two bathrooms. On the main deck is a bicycle track. To a most complete cold storage plant are added a system of electric lighting, electric fans and electric heaters. The dining room is 36×24, and can seat twenty-four persons. There are accommodations for thirteen officers and twenty-two seamen. There is a steel magazine for the ammunition for two breech-loading saluting guns, two Maxim guns, and several racks of Lee-Metford rifles. The yacht is equipped with two search lights.

It is believed that the government will buy several small fast steam yachts.

TELEGRAPHS AND TELEPHONES IN PERSIA.*

TELEGRAPHS.

THE first telegraph line in Persia was erected about thirty-six years ago, and in the beginning was vigorously denounced and opposed by the priests as being a species of magic and closely allied to other evil principles, greatly subversive of religion and the best interests of the state, and as such ought not to be permitted to have a place in the economy of government. This opposition, however, was overcome, and it will be seen further on that the class which resisted so stoutly at the first now use the telegraph with the most complacent indifference.

In the year 1862 the construction of a telegraph line from India to England, through Persia, Russia and Germany, was commenced and completed, and began working on the 1st of January, 1870. Some work had, however, been carried on for three or four years by a line through the Euphrates Valley; but this was not by any means of a satisfactory character, and serious errors, delays and interruptions on the line and in the messages occurred. This line is still used occasionally, but the working through Turkey cannot be depended upon.

The Indo-European, as the line now passing through Persia is called, is the joint property of the Indian government and a London company. The meeting point of their respective administrations is Teheran, the eastern division belonging to the government and the western to the company. It is generally considered to be a well constructed and efficiently managed line. From Bushire to Karachi there is both a cable and a land line. It is worked throughout by English operators. I mention this line because it provides the local native administration with one wire, which, so far as internal traffic is concerned, is the only one that can be depended upon.

The local lines, with the exception of the one wire mentioned above, are the property of the Persian government. The ownership was acquired at the cost of construction and it has been maintained by defraying the expenses of preservation. The actual administration is deputed to one man, who, until about two months ago, contributed to the government $12,000 a year. This royalty has now been raised to $30,000 a year, but I am told that the balance of receipts over expenditures will hardly be sufficient to meet the increase.

As Persians are very indifferent bookkeepers, and do not always study with care the relation between outlay and income, I regret to state that the record of telegraph construction has been no exception to that rule. I have, therefore, not been able to ascertain from any source what has been the actual cost of the erection of the lines. The configuration of the land surface and the state of the population, generally scant, would modify considerably the cost of construction. The poles, wire and all accessories for work have to be transported by mules and camels, which entails considerable expense. The lines being subject to many accidents and the inspection and control very indifferent, the working is by no means satisfactory.

The yearly receipts of the telegraphs have been about $60,000. As no new lines have been erected for some years past, the above is probably a fair average. I must, however, remark here that, when any department of the government revenue depends upon the system of farming, the income of the parties interested is always made to appear as low as possible, in order to prevent an increase in the government's demand.

The expenditure, including the late rise in the revenue payable to the government, will, I am told by the controller, equal, if not exceed, the income. They are, therefore, attempting some reforms which certainly seem to be needed, especially in the direction of compulsory payments. I am informed that fully 50 per cent. of the telegrams are sent gratis. Officials of the governments, central and local, priests, expounders of the law, relatives of persons connected with the working and administration, and every one who can provide himself with a reason or excuse, send their telegrams free of expense. As this system has been growing for many years past, and most of those who have benefited by it are in positions to give trouble, the management find it difficult to introduce changes necessary for their own protection.

The Persian local system comprises about 3,100 miles of wire and 86 offices for the receipt and dispatch of messages. The wire provided by the Indo-European administrations, gratis, is about 1,300 miles long, and extends from the Persian Gulf to the Russian frontier.

Stamps are not used for any purpose, in Persia, except for letters. Even documents of great value and importance give no indication of the cost of registration or other legal formality.

Messages are restricted to ten words, at a charge of 2½ krans* (25 cents). The actual charge for the message is 2 krans, and the half kran is for the paper on which it is written. In case the message extends to a large number of words, it is calculated at the rate of ten words to the 2 krans, and not 2½ krans. This tariff is the same for any distance in Persia: there is only one charge. I find that the administration does

* United States Consular Reports.

* The vice consul general values the kran at 10 cents, while the United States Treasury values it at only 7·6 cents.

not tabulate any department of the work; consequently, they have no idea of the number of words or the general or average distance the messages are sent.

The Persian newspapers rarely contain information of sufficient importance to be sent by telegraph; consequently, there is no press rate, and, indeed, very few press messages. There are four newspapers in Persia, printed in the vernacular and under government control. These should be issued once a fortnight, but they are often issued at longer intervals. They are in no sense considered as leaders or exponents of the ideas or feelings of the people, and I am afraid they are hardly accorded the importance they desire and deserve to attain.

It would be utterly impossible to estimate what is the actual value of the work performed by the Persian telegraphs in the course of a year. I am told that a large part of government work is never paid for, and it has been already shown what numbers and various people use the lines free of expense.

The late minister of telegraphs, who died a short time ago, and had been charged with the management from the introduction of lines into the country, was a man of a benevolent disposition and easy-going character, and in order to keep free of opposition, allowed those who had the power to injure his position to use his department for their advantage. Another order of things has sprung up and his eldest son, who has been confirmed in his place, finds it difficult to make both ends meet.

TELEPHONES.

The late Nasredin Shah, on the 8th of December, 1889, granted to the then minister for foreign affairs a concession for electric lighting, the introduction of telephones, phonographs, and the application of electricity to industrial purposes to the whole of Persia, with protection to the monopoly for the period of sixty years. This concession was transferred to Dr. W. W. Torrence, an American citizen, for a certain valuable consideration; but, for want of means, the purposes of the concession have not been put into execution. In order to protect the concession from lapsing, two or three wires were put up and kept in a workable state, and are now in use.

Five years ago the railway and tramway company began erecting private wires for anyone who would undertake the expense, and established an exchange office on their own premises in Teheran. It has not been extended to any other town. So far, no record has been kept of the number of miles of wire erected, but from my observations I should say not more than 50 miles—that is, including the wires into villages of summer resort and those to different parts of the city. At the present time there are fifteen owners of private wires, each of whom pays the company $2 per month for keeping the wires in repair and the instruments in order.

The receipts about balance the expenditures, but this includes the free use of the lines by the company, who provide the only office there is in the city and two in the country during the summer months.

As messages are not received from the public, no tariff has been formulated. Subscribers are put into communication and use the telephones as long as they wish.

The cost of construction has been about $390 per 1,100 yards.

As a more extended use of the telephone would interfere with the receipts of the telegraphs, permission to use it has not been granted to distances appropriated by the telegraphs.

JOHN TYLER,
Teheran. Vice Consul General in Charge.

AN ELECTROLYTIC PROCESS FOR THE MANUFACTURE OF PARABOLIC REFLECTORS.*

By SHERARD COWPER-COLES.

GLASS mirrors at the present time are almost exclusively used for projectors for search lights and similar purposes, on account of the difficulty that has been experienced in producing a true metallic reflector that will not readily tarnish when exposed to the heat of an arc light. One advantage of a metallic reflector is that the rays from the carbon points are collected into a parallel beam by means of refraction only, and is not catadioptric, as most glass mirrors are. Spun reflectors are never true, as it is found in practice impossible to spin them quite true to the moulds. Experiments have been made with a view to substituting cast metal for glass, but the cost of grinding and polishing, and the unsatisfactory surface that is obtained, have resulted in the attempts being abandoned. Stamped reflectors have also been tried, but with no more satisfactory results. The present process I propose to describe to you is an electrolytic one, one of the chief features being that the surface produced requires no after polishing or truing up. When once a true mould has been produced, any number of reflectors can be taken from it at a nominal cost. A glass mould is prepared, the convex side of which is accurately shaped and polished to form a true parabolic or other reflecting surface. As the mould only requires shaping and polishing on the convex side, it is comparatively cheap as compared to a glass reflector, which has to be ground on both sides. On the prepared surface is deposited a coating of metallic silver, which is thrown down chemically on the glass and then polished, so as to insure the copper backing being adherent to the silver. The mould thus prepared is placed in a suitable ring and frame (which I will describe later on), and immersed in an electrolyte of copper sulphate, the mould being rotated in a horizontal position, the number of revolutions being about fifteen per minute. The copper adheres firmly to the silver, and together they form the reflector, which is subsequently separated from the glass mould by placing the whole in cold or lukewarm water, and then gradually raising the temperature of the water to 120° Fah., when the metal reflector will leave the glass mould, due to the unequal expansion of the two. The concave surface of the reflector obtained is an exact reproduction of the surface of the mould, and has the same brilliant polish, and requires no further treatment to answer all the purposes of a reflector, with the exception that it must be coated with a film of some suitable metal to prevent tarnishing.

* A paper read before the Institution of Electrical Engineers, Wednesday, February 9, 1898.

Palladium is found to answer this purpose best, as a bright coating can be deposited rapidly to any desired thickness; the palladium resists tarnishing and the heat of the arc to a wonderful degree.

Palladium is a silver-white hard metal, and is sufficiently ductile to be rolled into thin sheets. Its specific gravity is about 12, being half that of platinum. The

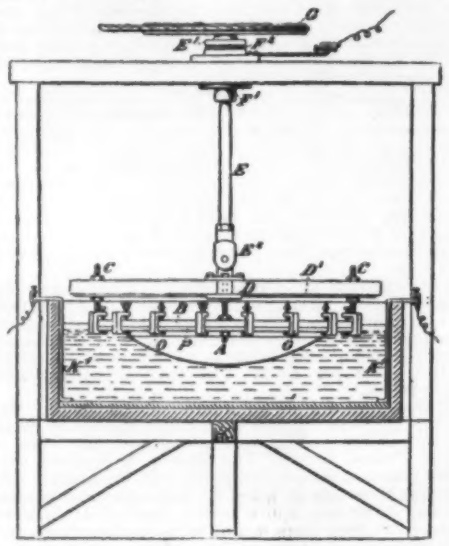


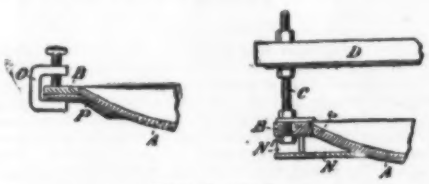
FIG. 1.

present price of palladium is about double that of platinum, but, its weight being only one-half, the same area can be covered at the same cost. It melts at an extremely high temperature—about the same as wrought iron. When only slightly heated in hydrogen gas it has an extraordinary power of absorbing mechanically large volumes of this gas. Graham investigated this very curious phenomenon, and found that a piece of palladium foil when heated below 212° Fah. takes 240 times its volume of hydrogen, but that it had not the power of absorbing oxygen or nitrogen. At a moderately high temperature palladium assumes a blue color, and the formation of a thin film of oxide, which it loses at a higher temperature, due to the decomposition of the oxide. Palladium is not readily attacked by sulphuric or hydrochloric acid.

In carrying out the manufacture of reflectors by this process, it is essential that the glass mould be perfectly clean and free from grease before the silver coating is applied. It has been found, however, that, if the cleaning is solely effected by chemical means, there

FIGS. 2 AND 3.

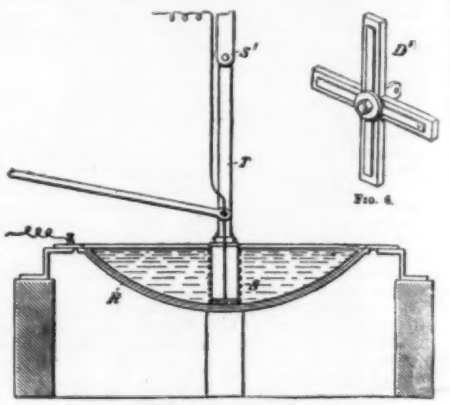
is a great liability of the silver adhering too firmly to the glass, whereby the mould is in danger of being broken during the removal of the reflector. This difficulty has been overcome by cleaning the glass mould with a suitable paste or powder, such as peroxide of iron, then removing such paste or powder by washing the glass with a 50 per cent. solution of ammonia. It is necessary that this cleaning operation be repeated prior to the production of each reflector. After the convex side of the mould has been properly cleansed as described, a thin coating of metallic silver is applied as follows: Ammonia is added to a solution of nitrate of silver until the precipitate that is first formed is redissolved, then reprecipitating by caustic acid, again dissolving in ammonia, then adding glucose to the solution. Excellent results have been obtained with a silvering solution of the following components, equal parts of each being used: Silver nitrate, 0·5 per cent.; caustic potash, 0·5 per cent.; glucose, 0·25 per cent.; The surface of the mould to be coated is immediately dipped into the solution, when it becomes coated with a film of silver. The silver coating is thoroughly washed, and then allowed to dry, and the silver which has been deposited is burnished bright with a piece of cotton wool and peroxide of iron, preferably precipitated by ammonia from a dilute solution of ferrous sulphate. The cost of the silvering is found to vary from 2d. to 4d. per inch diameter. I have here a film



FIGS. 4 AND 5.

of the silver and copper stripped from a glass mould, which is quite transparent to transmitted light having a green tinge, but is capable of reflecting light.

During the several operations that have been described, the glass mould (which in the case of large reflectors is of considerable weight) is handled by means of a sucker placed on the concave side of the mirror. The silver mould when silvered and burnished is placed in a ring, marked B in Figs. 1 and 3, which is attached to the frame, D; the ring serves to form an electrical connection with the silver coating. To determine the size of the reflector that is to be formed, and to insure a clean edge, a ring, N (Figs. 2 and 5), is placed, having the proper internal diameter, and bearing at its inner edge against the mould, as shown in the figures. Wooden blocks, N^1, of the required thickness are inserted between the rings, B and N, and the ring is secured in place by clamps, O, as shown on Fig. 2. The ring, N, may be made of insulating material, or it may be a brass, copper or lead ring, having its lower face protected by suitable varnish to prevent the deposition of metal upon it. The ring, B (Fig. 1), is suspended by bolts, C, and cross bars, D, forming a frame which is connected to vertical shaft, E; the said shaft is carried on the main frame, E, of the apparatus by a bearing fitted with ball bearings marked F^2, which supports the shaft by means of a collar, and is allowed to rotate freely. G is a pulley through which shaft, E,



FIGS. 6 AND 7

and mould, A, may be rotated by a belt or cord. The depositing tank is carried by a frame, to which the mould is suspended, so as to be in contact with the electrolyte, which is a solution of copper sulphate; the anode is arranged at the bottom of the tank, and the current conveyed to it by means of copper strips. It is found advantageous to have the anode flat, as it reduces the tendency for the copper to "tree" at the edge of the mould; it also has the additional advantage of rendering the reflector thicker in the center. The electrical connections between the negative terminal and the silver coating of the reflector are made through the ring, B, bolts, C, strips of metal, D^1, on the arms of

FIG. 8.

the frame, D, the shaft, E, the ball bearing, F^2. Fig. 6 is a perspective view of the cross frame for suspending the mould, and shows the metal strips for conveying the electric current. The connection of the frame to the shaft is made by a joint, E^2, that allows of the mould being tilted, for the reason that I will now describe to you. When first lowering the mould into the solution, it is advisable to avoid throwing the work of carrying the whole electric current on the silver alone, so the shaft, E, is raised by means of pulley blocks, or otherwise, to suspend the mould. The mould is then tilted and the shaft gradually lowered, bringing the

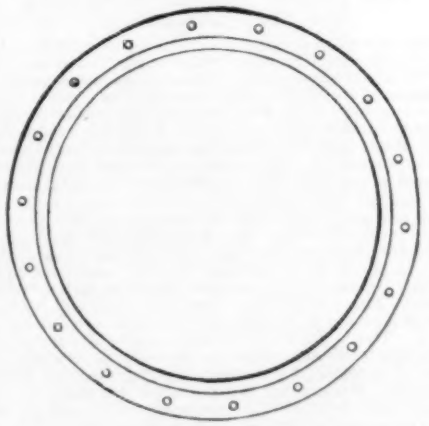


FIG. 9.

edge of the mould in contact with the electrolyte, the circuit being thus established. A thin film of copper is deposited on the mould at the place of contact near the edge of the mould. The shaft is then lowered until it rests on the bearing; at the same time the

mould is allowed to gradually assume its horizontal position. The operation I have just described occupies a very brief interval of time, and the current for a few minutes is worked at a pressure of about 9 volts, which is ultimately reduced. It is very important that the silver be flashed over with copper immediately on immersion in the copper sulphate solution. At this stage the ring, N, is not applied, and the mould simply rests on the ring, B. The shaft is then rotated, and the operation of depositing the base metal continued with a current density of about 19 amperes per square foot, and is proceeded with until a sufficiently thick coating is obtained to act as a good conductor to the electric current. The copper solution generally used is of the following composition: Copper sulphate, 13 per cent.; sulphuric acid, 3 per cent.; water, 83 per cent. The ring, B, with the mould in it, is then lifted out of the bath, and the ring, N, applied to determine the size of the reflector that is to be formed; after which the mould is again placed in the bath, and the operation of depositing the backing proceeds until the required thickness is obtained. During this stage the copper is deposited on the mould up to the inner edge of the ring, N, which thus determines the diameter of the reflector, and also insures a clean, even edge to the reflector, which requires no further treatment. In place of the ring, N, shown in Figs. 2 and 5, a leaden ring, P, Fig. 4, may be employed. The leaden ring is secured to the ring, B, by the clamps, O; this ring, being soft and pliable, will bend to the angle of the mould and the ring, B, and therefore does not require to be blocked up as does the ring, N. Fig. 3 shows a modification of a mould having its edges beveled in the direction indicated—that is to say, in the reverse direction to that shown in Fig. 2. In such cases the mould is supported by a number of narrow rigid supports, Q, clamped to the ring by clamps, O. After the thin coating of copper has been applied to the mould in the manner already described, the ring, B, with the mould in it, is removed from the bath and turned over. The supports, Q, are then removed, and a ring such as P, Fig. 4, is applied to the mould to determine the size of the reflector. Or, instead of removing the supports, Q, and applying the ring, P, if a ring such as N, Fig. 2, can be applied to the mould, it is then replaced in the bath and the depositing continued. As soon as the requisite thickness of metal has been deposited, the mould, with the reflector attached to it, is removed from the ring, B, and placed in a bath of cold or lukewarm water, which is then raised to a temperature of 120° Fah.; whereupon, owing to the difference of the expansion of the glass mould and the metal backing, the latter separates from the mould. The only thing that requires to be done now is to coat the reflector with an untarnishable metal. This is accomplished by placing the reflector in an earthenware pan (Fig. 7) containing a 0·62 per cent. solution of palladium ammonium chloride in about a 1 per cent. solution ammonium chloride. The solution is used at about 75° Fah., the current used for a 2-foot reflector being about 0·5 of an ampere, the E.M.F. at the terminals of the bath being 4 to 5 volts. An anode, S, made out of carbon, and curved approximately the shape of the reflector, is attached to a rod, marked T, which is connected by an arm to a rotating disk which causes the anode to swing to and fro, thereby insuring an even coating of palladium, and agitating the solution and preventing the depositing upon the reflector of particles of foreign matter which may be present in the solution.

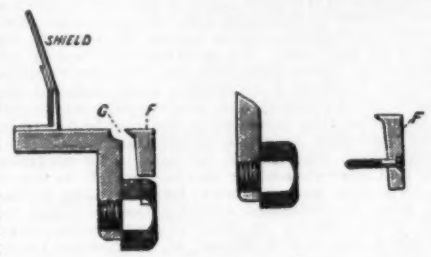
The back of the reflector is usually varnished before placing it in the bath, to prevent local action setting up between the copper and the silver or palladium. The reflector is removed from the bath and dipped in boiling water, and then placed in boxwood sawdust, which is kept hot by means of a steam jacket. The reflector is then ready to be mounted in a suitable ring, as shown in Figs. 8, 9, 10, 11 and 12. The clamping ring shown in Fig. 8 is provided with a knife edge, marked F, Figs. 10 and 12. The knife edge forces the reflector against a ring of asbestos, marked G, and retains it in position after the reflector has been carefully centered while resting on the asbestos ring.

Reflectors made by the process which has just been described have been subjected to a number of tests, and found to withstand excessive heat without tarnishing. Salt water has been thrown on the reflectors when they have been too hot to touch, the result being that the water was driven off as steam, and the salt left as a white deposit on the reflector, which was easily removed with a wet cloth.

A reflector recently tested at Portsmouth had a number of rifle bullets passed through it, when the beam was found to be little affected. On the other hand, the first shot fired at a glass reflector splintered it to pieces.

Although palladium does not reflect light as well as a silver surface which is perfectly clean and bright, silver is found quite unsuitable, as after being in close proximity to an arc light for a short time the silver tarnishes and the light is greatly reduced in intensity. With a palladium-faced reflector the intensity of light is found to remain practically constant, as little or no tarnishing takes place.

Some of the reflectors have been tested optically by the process which has been extensively used by Thikoff. The method consists of photographing the image in a reflector of a white screen covered with black square network, as shown in Fig. 13. The screen is of white material, having a black square network,



FIGS. 10, 11 AND 12.

the lines being 0·2 inch thick and 0·6 inch apart. In the center of the screen a square opening is left through which the photograph of the image of the network is taken. The first steps in the process are as follows: The reflector is placed at a distance of from 3 feet to 5 feet from the screen, which should exceed by at least 35 per cent. the height and breadth of the reflector, so as to insure the image of the network covering the whole surface of the mirror. The test of the reflector is carried out as follows: The surface of the mirror in all planes is tried by a template, to insure that the exterior curves of the surface are not far distant from the parabola; the image on the screen is then photographed and the irregularity of the lines indicates any serious errors of the parabolic surface.

THE ATOMIC WEIGHTS OF NICKEL AND COBALT.

THE determination of the atomic weights of nickel and cobalt has attracted a considerable amount of attention during the last few years, the numbers obtained by different workers exhibiting relatively startling variations. Thus, including only the four most recent results, the values for cobalt vary between 58·78 (Hempel and Thiele, 1895) and 60·12 (Schützenberger, 1892). Similar variations observed for nickel by Krüss led him to the conclusion that this metal contained a new element, to which he gave the name of "gnomium;" but recent work has not tended to confirm this view. In The Proceedings of the American Academy of Arts and Sciences for November and December last are two important contributions to this subject, by Richards and Cushman and Richards and Baxter respectively, giving the results of analyses of the bromides of nickel and cobalt, which show in a decisive manner that properly purified nickel and cobalt are homogeneous substances. After stating the advantages pertaining to the use of the bromides, for the sublimation and bottling of which a highly ingenious apparatus is described, they show how two totally distinct methods of purification, starting from metals of different origin, lead to a bromide of the same composition.

For nickel bromide the material was obtained from two sources, the "pure" nickel of commerce and Mond nickel prepared by the carbon monoxide process. The steps for the purification of the first of these included fractional precipitation as sulphide, then as hydroxide, conversion of this through the bromide into the violet crystalline ammonia compound $NiBr_2.6NH_3$, and this, after several recrystallizations, converted through the oxide into spongy nickel. For the Mond nickel, in which a little iron was practically the only impurity, the same process was adopted, except that to remove alkalies the hydroxide was converted into sulphate and the latter subjected to electrolysis several times. After conversion into bromide, these were analyzed, and for the final analyses further purification was attempted by repeated deposition by electrolysis. All three samples gave identical results, 58·69, for the atomic weight of nickel (O = 16).

The cobalt was purified with equal care, the cobalt bromide being obtained by two distinct methods of purification, the one through potassium-cobalt nitrite and the other through a cobalt-amine, and these again purified by a combination of both processes. The results of the three series were practically identical, the atomic weight of cobalt being 58·99 (O = 16).

While recognizing that data obtained from one compound only are not sufficient to finally settle the atomic weights of these metals, the authors conclude that if "gnomium" exists, it must have an atomic weight equal to that of nickel and cobalt; and hence, that the wide variations observed in the results of other experimenters cannot be considered a valid argument in favor of the late Prof. Krüss' doubtful discovery.—Nature.

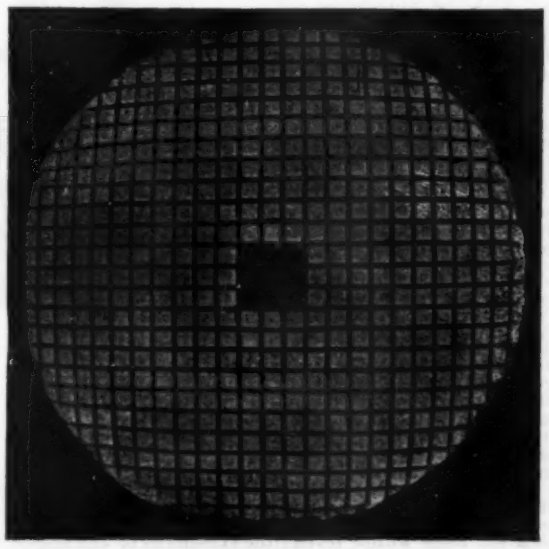


FIG. 13.

ABSTRACT OF REPORT OF THE COMMISSIONER OF PATENTS FOR 1897.

DEPARTMENT OF THE INTERIOR,
UNITED STATES PATENT OFFICE.

Washington, D. C., January 31, 1898.

To the Senate and House of Representatives of the United States of America in Congress assembled:

By reason of the death of Commissioner Butterworth on January 16, it becomes my duty as Acting Commissioner to lay before Congress the report called for by the statute.

The lists of patents and patentees called for by the statute are appended to this report. The statement of receipts and expenditures is as follows:

RECEIPTS.

Detailed statement of all moneys received for patents, for copies of records or drawings, or from any source whatever.

Applications:	
Cash received	$1,224,291 00
Cash refunded	5,834 00
Net cash	1,218,457 00
Certificates of deposit	33,540 00
Total cash and certificates	1,251,997 00
Copies:	
Cash received	96,782 46
Cash refunded	8,573 28
Net cash	88,209 18
Certificates of deposit	322 27
Total cash and certificates	88,531 45
Recording assignments:	
Cash received	22,719 66
Cash refunded	1,093 68
Net cash	21,625 98
Certificates of deposit	134 00
Total cash and certificates	21,759 98
Subscriptions to Official Gazette:	
Cash received	13,069 54
Cash refunded	47 35
Net cash	13,022 19
Certificates of deposit	55 10
Total cash and certificates	13,077 29
Registration of prints and labels:	
Cash received	546 00
Cash refunded	270 00
Net cash	276 00
Certificates of deposit	
Total cash and certificates	276 00
Aggregates.	
Cash received	$1,357,408 66
Cash refunded	15,818 31
Net cash	1,341,590 35
Certificates of deposit	34,051 37
Total cash and certificates	1,375,641 72
Aggregate amount of expenditures,	1,122,843 13

RECEIPTS OVER EXPENDITURES.

Total receipts	$1,375,641 72
Total expenditures	1,122,843 13
Receipts over expenditures	252,798 59

Statement of Balance in the Treasury of the United States on Account of the Patent Fund.

Amount to the credit of the fund January 1, 1897	$4,718,639 47
Amount of receipts during the year 1897	1,375,641 72
Total	6,094,281 19
Deduct expenditures for the year 1897	1,122,843 13
Balance January 1, 1898	4 971,438 06

SUMMARY OF THE BUSINESS OF THE PATENT OFFICE.

Number of applications for patents for inventions	45,661
Number of applications for patents for designs	2,150
Number of applications for reissues of patents	94
Total number of applications	47,905
Number of caveats filed	2,176
Number of applications for registration of trade marks	1,946
Number of applications for registration of labels	66
Number of applications for registration of prints	26
Number of disclaimers filed	5
Number of appeals on the merits	1,142
Total	5,361

Total number of applications, etc., requiring investigation and action.	53,266
Number of patents issued, including designs	23,729
Number of patents reissued	65
Total	23,794
Number of trade marks registered	1,671
Number of labels registered	14
Number of prints registered	16
Total	1,701
Number of patents expired during the year	12,926
Number of patents withheld for non-payment of final fees	4,891

SUMMARY OF TABLES.

In 1897 there were received 45,661 applications for patents, 2,150 applications for designs, 94 applications for reissues, 2,176 caveats, 1,946 applications for registration of trade marks, 66 applications for registration of labels, and 26 applications for prints. There were 23,729 patents granted, including designs, 65 patents reissued, 1,671 trade marks registered, and 14 labels and 16 prints. The number of patents that expired was 12,926. The number that were forfeited for non-payment of the final fee was 4,891. The total expenditures were $1,122,843.13; the receipts over expenditures, $252,798.59. The total balance to the credit of the Patent Office in the Treasury of the United States on January 1, 1898, was $4,971,438.06.

In proportion to population more patents were issued to citizens of Connecticut than to those of any other State—1 to every 786 inhabitants. Next in order are the following: Massachusetts, 1 to every 1,180; District of Columbia, 1 to every 1,316; New Jersey, 1 to every 1,377; Rhode Island, 1 to every 1,421; New York, 1 to every 1,585. The fewest patents were granted in proportion to the number of inhabitants in the following States: South Carolina, 1 to every 38,371; North Carolina, 1 to every 17,397; Mississippi, 1 to every 16,120; Alabama, 1 to every 15,598; and Georgia, 1 to every 14,133.

THE SCIENTIFIC LIBRARY.

The needs of the scientific library have been repeatedly urged in reports of Commissioners. A full report on this library was appended to the report of Commissioner Seymour for the year ending December 31, 1893.

The library, it is to be remembered, is in no sense a circulating library. It is purely technical in its character and is intended for no other purpose than the investigation and study of the literature of the industries. No books are permitted to be withdrawn from it except by those engaged in the examination of applications, and when withdrawn by them are not permitted to be taken from the building except with the approval of the Commissioner. It is open for consultation by the employes of other departments of the government and by the public. It often happens that it is of great importance to the public service that information should be obtained as to what has been done abroad, as well as in this country, in particular lines of industrial development and in the investigation of questions as to which practical difficulties are found to exist. In these matters the scientific library of the Patent Office is in many cases found to be the best available source of the information desired. It is an absolute necessity in order to enable the novelty of inventions to be ascertained with certainty. As it stands to-day, it is for its purpose probably unsurpassed by any library in the world. Yet it is far from complete and far from satisfactory. It needs for the purchase of books necessary to bring it up to date not less than $10,000 and an annual appropriation of not less than $5,000.

LABORATORY.

Attention has repeatedly been called in the reports of Commissioners to the need of a suitable laboratory. Questions frequently arise in reference to applications for patents relating to chemical, electrical and metallurgical inventions which can be decided satisfactorily only by practical test and experiment. Some apparatus has been presented to the office for laboratory use and the office has had the use of apparatus which is the personal property of examiners, but even when thus supplemented the laboratory is but meagerly equipped. An inconsiderable sum would secure the necessary apparatus to equip a laboratory which would meet every requirement, and such sum as is necessary should be provided.

PATENT BAR.

For years the necessity for the establishment of a patent bar has been recognized. The laws governing the grant of patents are not as fully understood by the general public as they should be. The inventor who for the first time seeks a patent, particularly if he resides at a distance from the larger cities, generally believes that all that he needs in order to secure protection for his invention is a document issued by the Patent Office and bearing its seal. He does not know, apparently, that however valuable his invention may be, the patent issued therefor may, if not properly drawn, fail to protect him against infringers and be practically worthless and be no more in effect than a notice to all the world that the invention may be used by any one without paying royalty to the inventor. Many such inventors, knowing of no patent solicitor in their neighborhood, trust their inventions to some pretended patent attorney, who, without the experience or qualifications necessary to render applicants for patent valuable service and without the high sense of obligation to the interests of his clients and with no purpose beyond securing fees from the inventors, spreads high sounding, self-laudatory, and utterly unprofessional advertisements broadcast over the country. Under the over-liberal rule of practice by which "any person of intelligence and good moral character may appear as the agent or attorney in fact of an applicant," not a few such attorneys have in the past been permitted to practice before the office, with the result that, on applications badly prepared and unskillfully and carelessly prosecuted, patents were issued which, while valid for all that they claimed, were worthless in that they failed to adequately protect inventions which, properly claimed, might have been worth thousands of dollars. Such practitioners in not a few cases have through ignorance, inexcusable in those pretending to be competent attorneys, and in some cases through willful deceit, induced would-be inventors to pay them fees for the preparation and prosecution of applications for devices which were upon their face unpatentable and worthless. Such applications are of necessity rejected by the Patent Office, and the result has often been that the applicant not only loses the fees paid to the attorney, which are not inconsiderable, notwithstanding that such attorneys advertise to do their work cheaply and to prepare and prosecute the application for fees less than would fairly pay for conscientious and skillful work, but is some times led to believe the Patent Office untrustworthy and in league with unprincipled attorneys for the purpose of defrauding him.

In defense of the good name of the Patent Office and in the interest of inventors and the public an earnest attempt to correct abuses in the practice was made during the past year. An attorney who had by practices such as above described and practices which savored even more of a confidence game induced thousands of the unlearned and unwary all over the country to intrust their business to him and to pay to him, in the aggregate, hundreds of thousands of dollars for advice which was known by him to be contrary to their real interests and for services which, as was well known to him, were and could be of no value to them, was, after a protracted investigation covering more than three months, in which every possible chance was given him to free himself of the charges brought against him, upon the admission of his own witnesses and the facts stipulated to be true by his own counsel, denied the privilege of further practicing before the Patent Office. So utterly fraudulent were the practices of this attorney that subsequent to his disbarment from practice he was, after a second thorough inve-tigation, denied the use of the United States mails by the Postmaster-General.

This disbarment was followed by the disbarment of several less prominent attorneys who were guilty of similar practices. Its effect has been most salutary, and it is believed that to-day the practice before the Patent Office, though not entirely free from evils, is on a higher plane than ever before.

THE NEW LAW.

The act of March 3, 1897, making certain needed changes in the patent statutes, took effect January 1, 1898. By the changes made by this act, applications for patents for inventions previously patented abroad on applications filed more than seven months prior to applications in this country were made unpatentable after December 31, 1897. A large number of such applications were filed in December, the receipts for the last week of that month being the largest for any week in the history of the office. Yet, for causes in many cases beyond the control of the applicant, a considerable number of applications on which valid patents could have been granted if they had been filed on December 31 failed to reach the office on that date. I believe that an act permitting such belated applications to be received as if filed under the old law would be just to the applicants and would not be injurious to the public.

THE CONFERENCE AT BRUSSELS.

The international convention as originally agreed to in 1883, while it was a long step toward the result desired, did not in all respects prove satisfactory. From the fact that it is ordinarily many months before a patent is granted on an application filed in the Patent Office, even when the office force is sufficient to enable the examination to be made promptly, the time being obviously much longer with the office force so insufficient in numbers as it is at present, the delay of priority under the convention, being but seven months and beginning from the date of filing of the application, is of little practical advantage to our citizens, particularly as it has been generally understood that the application filed in a foreign country under the convention must correspond precisely with the application as originally filed in this country, and not the application as amended to restrict it to the invention found on examination to be patentably new. In some other respects the convention has proven unsatisfactory to our citizens.

For the purpose of making such changes in the convention as should make it satisfactory to all the members of the Union, conferences have from time to time been held. At each of these the United States has been represented. At the conference at Madrid in 1890 the representatives were Mr. Francis Forbes, of New York, and Examiner F. A. Seely, of the Patent Office. At the conference at Brussels in December, 1897, the United States was represented by Mr. Francis Forbes and Hon. Bellamy Storer, the United States Minister to Belgium. Full reports of this last conference have not yet been received, but it is understood that substantial progress was made toward such modification of the convention as will bring it more nearly in harmony with the needs of our inventors.

The feature of the convention which is of greatest importance to our inventors is the so-called "delay of priority." This is of peculiar importance in those countries in which any publication of a description of the invention or any use of the invention in the country prior to the filing of the application invalidates the patent granted for the invention. Under the provisions of the convention an inventor having filed his application in the Patent Office may thereafter exploit his invention in any of these foreign countries and yet, provided he file his application there within seven months from the date of filing his application here, obtain a valid patent. The opportunity thus given to determine by actual test whether or not the invention will be of value in that country may obviously be of great advantage.

THE INTERNATIONAL REGISTRATION OF TRADE MARKS.

In connection with this International Union, the Union for the International Registration of Trade Marks is of importance. This subordinate union was formed at the conference at Madrid in 1890 and concluded by an arrangement signed at Madrid April 14, 1891. It includes at present nine nations. The purpose of this union is to enable a citizen or subject of one of the members of the union having registered his trade mark in his own country to secure registration of that mark in all the other countries of the union without the difficulties and delays attendant upon applying separately for registration in each country. The United States is not at present a member of this union. The manner of effecting this international registration is for the owner of the trade mark, having registered it in his own country, to make application through the State Department or Foreign Office to the Bureau of the International Union, which is located at Berne, for international registration, paying a fee of 100 francs ($20). This bureau notifies the several members of the union and registration is effected in each of them without further fee.

The importance of having trade marks protected, and in many countries registration is necessary to protection, has been forcibly impressed upon American manufacturers, who, sending their goods into some foreign country, have found the very trade mark which has become of value to them registered in that country to some citizen of that country who made application for registration for no other purpose than to enable him to demand of the American manufacturer a price for the right to sell goods marked with that trade mark in that country. As in a number of European countries registration of a trade mark is attributive of property in such mark and is granted, not to the first adopter and user of the mark, but to the first applicant for registration, and as in these countries the registrant can under the laws there in force forbid the importation of goods marked with the trade mark registered by him, or even compel the seizure of such goods, it is evident that such registrant has the manufacturer who is the rightful owner of the mark completely at his mercy so far as trade in that country is concerned.

I am informed that in at least one European country citizens of that country have registered the trade marks used by a number of American bicycle manufacturers and are in a position to prevent the trade of such manufacturers with that country except under such conditions as the registrants may choose to dictate.

It is believed that the international registration of trade marks, which may be effected through this union, would be of material value and is practically indispensable to those of our manufacturers who desire to develop their foreign trade. In the interest of these manufacturers the United States should become a member of this union.

(To be continued.)

THE PHONENDOSCOPE.

IN order to ascertain the state of our organs, the physician has recourse to his ear. He auscultates the

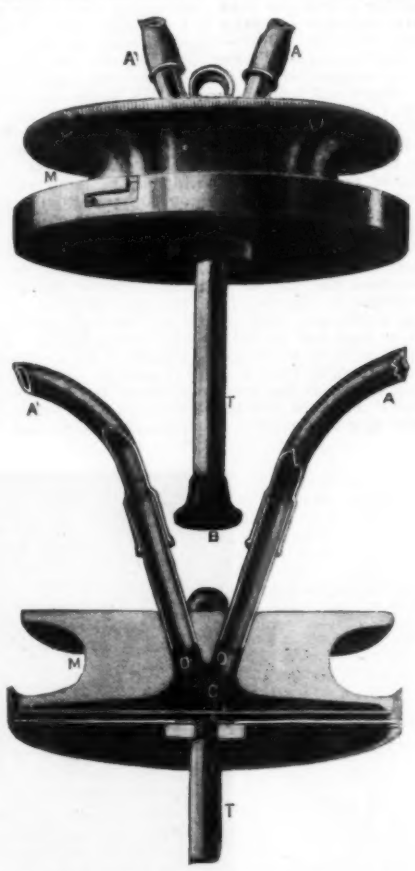


FIG. 1.—THE PHONENDOSCOPE.

sounds that the internal functions produce, and then, through percussion, he produces the sounds himself. He places the second finger of the left hand upon the organ to be examined and with the right hand (the extremities of the fingers being bent) gently taps it. If the organ is compact, like the liver, the heart, or a bone, the sound that is rendered is dull; but, if the organ is light and full of gas, like the lungs or the stomach, the sound is sonorous. An organ that is sonorous in a normal state may become dull if it is diseased. Thus, a lung attacked with pneumonia or pleurisy becomes dull.

As the sonorousness is greatly differentiated, the appreciation is easy. But this is not always the case, and when it is not it is necessary to have a musical ear and considerable experience in order to ascertain whether or not the organs are displaced, hypertrophied or diseased. The celebrated Piorry excelled in making the most subtile distinctions with an instrument of his invention called the plessimeter.

Drs. Bianchi and Bazzi, desirous of simplifying such investigations, have constructed a new apparatus, the phonendoscope, which permits the least sensitive ear to detect the differences in sound.

The problem was as follows: As the sound that is produced by tapping upon the organ becomes scattered, and as the ear is distant and receives but a part of it, there is needed an instrument that shall collect the vibrations, condense them, and carry them integrally to the ears. The phonendoscope attains this object; let us examine its structure.

The instrument consists of a solid metallic rod, T, terminating in an ebonite button, B. This rod collects the vibrations and transmits them to a disk of ebonite sufficiently strong to withstand the pressure of the rod

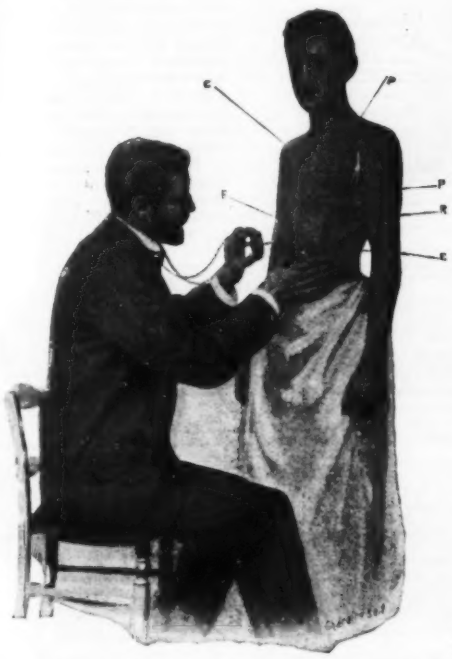


FIG. 2.—DR. BIANCHI OBTAINING THE OUTLINES OF THE LIVER BY MEANS OF THE PHONENDOSCOPE.

E, stomach; F, liver; C, heart; P P', lobes of the left lung; R, spleen.

when it is applied to the body. This disk comes into contact with a second and thinner one of the same material capable of vibrating easily. This thin disk is set into a mass of metal, M, of the size of a large watch. Between the disk of the mass there is an air space, C.

The sound produced by the disk is condensed by the metallic walls of this space, and carried to the orifices, O and O', in which are fixed acoustic tubes, A and A'.

Let us suppose, now, that we wish to examine the heart. We select upon the chest a point at which the latter is in direct contact with the thoracic wall. Such selection is important, since if an organ (a pulmonary lamina, for example) were interposed between the heart and the wall, the instrument might not collect the vibrations produced by the former, because of their being arrested in great part by the lamina.

We therefore place the button of our rod upon this definite point, hold the rod at right angles with the thoracic wall, and depress the skin by means of the instrument. With the free second finger of the right hand we compress the skin so as to approach the organ to be examined, and then rub with the tip of this finger. The organ situated beneath begins to vibrate. The vibrations, which would not be perceived by the ear, are transmitted to the phonendoscope, which condenses them, amplifies them and sends an intense sound into the acoustic tubes.

As we have said, the interposition of another part attenuates the intensity of the sounds without destroying them. Thus, if a pulmonary lamina happens to be interposed between the heart and the finger that is doing the rubbing, the latter again causes the heart to vibrate through such lamina. Upon the whole, every organ that comes into direct contact with the external envelope of the body, even if it be at only one point, will therefore be able to furnish its projection upon the skin, and the contours thereof may be drawn by means of a colored crayon.

Another advantage of the instrument invented by Drs. Bianchi and Bazzi, and which it shares, moreover, with the phonograph, is that several persons can hear at the same time, it being only a question of the number of acoustic tubes to be arranged upon the apparatus. This is a valuable advantage for clinical instruction.

With the phonendoscope we hear the organs in a living and moving state. All our organs, in fact, are in a state of perpetual motion. Their position differs according as one is standing, leaning or lying upon the side, back or breast. In order to obtain comparable results, phonendoscopic examination is practiced by preference upon a subject in an erect position. As an example that well marks the utility of the new discoveries that have been made by means of the phonendoscope, let us take the examination of the stomach.

Up to the present, in treatises upon anatomy, the stomach has been made to assume the form that it takes in the cadaver. It has been impossible, in fact, to sketch it from a living subject, and impossible, especially, to recognize the lower part of this organ by percussion. We find by means of the phonendoscope that the stomach, even when empty, is more elongated in a vertical direction than most anatomists think. It is drawn out still more in this direction when it receives food.

Let us drink a glass of water. It was formerly thought that water does not remain in the stomach. There exists, it was said, a special bundle of muscular fibers called the "Swiss cravat," the contraction of which causes the liquid to pass directly from the cardia into the pylorus, and from the œsophagus into the intestine. Nothing is more false. The Swiss cravat does not exist; the stomach preserves liquids as food. In order to empty itself, it elongates in a transverse direction. The line of level of the liquid ascends and reaches the pyloric orifice and the liquid is evacuated in measure as the bottom of the stomach rises. The advantage of a dry diet for weak stomachs will be readily understood. As beverages remain in the stomach along with the food, the weight imposed upon this organ is diminished by just so much through the suppression of liquids.

The stomach frees itself more or less quickly according to the nature of the liquid. It became of interest to study the variable stay of beverages in the stomach, so that it would be possible to recommend to dyspeptics those that remain therein the shortest time. Thanks to the use of the phonendoscope, Drs. Bianchi and Comte have been able to make drawings of the same stomach fasting, A (Figs. 3 and 4); at the moment of the ingestion of 500 grammes of liquid, B; and, finally, two hours after such ingestion, C. The results of their labor have been given in a remarkable report to the congress of Moscow.

In Fig. 3 (A) we see the stomach nearly empty; containing but a very small quantity of liquid. When it is filled with 500 grammes of water, its lower part elongates like a large purse and assumes a wide vertical diameter. Two hours afterward it is in great part empty, and has nearly resumed its first form. Let us take a beverage that produces an abundant disengagement of gas, and of which seltzer water is the type. The stomach will expand, and have a much larger gas chamber. It will take a longer time to empty itself, and two hours afterward it will still contain a large amount of liquid. Beer produces the same effects. The big bellies of those who drink large quantities of beer is well known.

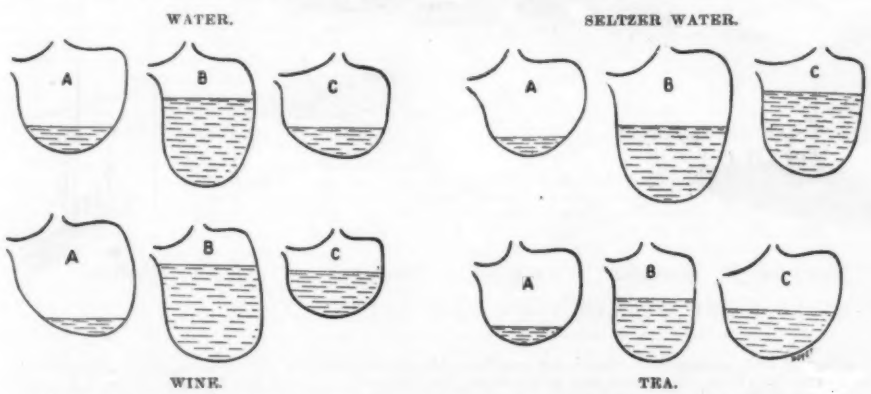
Nutritive liquids, such as milk and chocolate, pass off more rapidly. Two hours after ingestion the stomach is smaller and contains less liquid.

Wine also passes off rapidly. The stomach contracts through the irritation produced by the alcohol and causes hunger; and the rapid contraction of the organ explains, too, the awakening of the appetite caused by aperients. On the contrary, beverages that produce an abundant disengagement of gas appease hunger by expanding the stomach. Bouillon and soup allay hunger and appear to be nourishing; but they merely "stay the stomach," and the need of food rapidly brings on the sensation of hunger again.

Hot and aromatic beverages are the ones that the stomach digests most easily. In this category we shall place coffee and tea. Two hours after ingestion the stomach is contracted, and no longer contains anything but a feeble quantity of liquid.

Conclusion: Drink ordinary water, and do not abuse gaseous beverages, which have lost their reputation as digestive beverages, save in certain pathological cases of which the physician is sole judge.

How much light is thrown upon the phenomena of digestion by the use of the phonendoscope may be readily seen. We are merely at the threshold of the useful results that we have a right to expect from this ingenious instrument. It would be impossible to be too grateful to Dr. Bianchi for having furnished medicine with a new and fecund method of scientific investigation.—Felix Regnault, M.D., in L'Illustration.



FIGS. 3 AND 4.—DIGESTION OF WATER, WINE, SELTZER WATER AND TEA.

A, stomach fasting; B, form of the stomach after the ingestion of two pints of liquid; C, two hours afterward.

ARTIFICIAL FERTILIZERS FOR POT PLANTS.

A PLANT, in order to thrive properly, must grow in a soil that furnishes the necessary inorganic matters as food; if these are not present, or present only in small quantity, the plant either dies, or grows scantily, or develops only certain portions of its structure. Thus, grain grows only small and undeveloped seeds, if the soil does not contain enough phosphoric acid. As regards the organic food, plants are less dependent on the soil, as this is derived directly or indirectly from the atmosphere. As plants vary in the kind of mineral matter required, and the available mineral constituents in the soil also differ greatly in different localities, it is often necessary for the proper development of certain plants to add certain substances to supply the deficiency. Some plants require principally one kind, some another, as lime, silica, potash or salt. Experiments on vegetation have shown that a plant will thrive perfectly when the lacking substances are supplied in a suitable form, e. g., in the following combinations:

1.	2.
Calcium nitrate,	Calcium nitrate,
Potassium nitrate,	Ammonium nitrate,
Potassium phosphate,	Potassium sulphate,
Magnesium phosphate,	Magnesium phosphate,
Ferric phosphate,	Iron chloride (or sulphate),
(Sodium chloride).	(Sodium silicate).

It is well known that in nature nitrates are formed wherever decomposition of organic nitrogenous substances takes place in the air, the ammonia formed by the decomposition being oxidized to nitric acid. These conditions for the formation of nitrates are present in nearly every cornfield, and they are also the cause of the presence of nitrates in water that has its source near stables, etc. In Peruvian guano nitrogen is present partly in form of potassium nitrate, partly as ammonium phosphate and sulphate. In form of nitrate it acts more rapidly than in form of ammonia, but in the latter case the effect is more lasting. Phosphoric acid occurs in guano combined with ammonia, potash and chiefly with lime, the last being slower and more lasting in action than the others. These results of chemical experiment are the basis of a flourishing industry, the manufacture of artificial fertilizers, and also the flower lover has entered the field on a small scale, and many preparations under various names have been placed on the market, nearly all of which conform more or less to one of the above mentioned general formulas and can be readily prepared and sold advantageously by the pharmacist.

Artificial flower fertilizer:

	1	2	3	
Ammonium nitrate	0·40	1·60	40·0	gm.
Ammonium phosphate	0·20	0·80	20·0	"
Potassium nitrate	0·25	1·00	25·0	"
Ammonium chloride	0·05	0·20	5·0	"
Calcium sulphate	0·06	0·24	6·0	"
Ferrous sulphate	0·04	0·16	4·0	"
	1·00	4·00	100·0	gm.

Dissolve 1 gm. in 1 liter of water, and water the flowers with it two or three times weekly. Dissolve 4 gm. in 1 liter of water, and water with this quantity 10 or 12 pots of medium size.

Compost for indoor plants:

	1	2	3	
Ammonium sulphate	0·30	1·20	30·0	gm.
Sodium chloride	0·30	1·20	30·0	"
Potassium nitrate	0·15	0·60	15·0	"
Magnesium sulphate	0·15	0·60	15·0	"
Magnesium phosphate	0·04	0·20	4·0	"
Sodium phosphate	0·06	0 24	6·0	"
	1·00	4·00	100·0	gm.

1 gm. to be dissolved in 1 liter of water and the flowers watered up to three times daily. Dissolve 4 gm. in 1 liter of water, and water with this solution daily:

Plant food solution:

	1		2	
Potassium chloride	0·16	or	12·5	gm.
Calcium nitrate	0·71	or	58·0	"
Magnesium sulphate	0·125	or	12·0	"
Potassium phosphate	0·133	or	15·0	"
Iron phosphate, recently precipitated	0·032	or	2·5	"
	1·160	or	100·0	gm.

This turbid mixture (1·16 or 1·0 gm. in 1 liter) is used alternately with water for watering a pot of about 1 liter capacity; for smaller or larger pots in proportion. After using the amount indicated, the watering is continued with water alone.

Fertilizer with organic matter, for pot flowers:

Potassium nitrate, Ammonium phosphate	aa	100·0 gm.
Phosphoric acid		2·5 "
Simple sirup		1 liter.

Add not more than 10 c. cm. to a liter of water, and water alternately with this and with water alone. For Cactaceæ, Crassulaceæ and similar plants, which do not assimilate organic matter directly, use distilled water instead of sirup.

Chlorotic plants are painted with a dilute iron solution or iron is added to the soil, which causes them to assume their natural green color. The iron is used in form of ferric chloride or ferrous sulphate. (Pruys in Ph. Ztg., through Ph. Rundschau.)—Pharmaceutical Era.

The value of bicycles manufactured in Birmingham and Coventry, England, during 1896, amounted to $60,000,000. About 75,000 bicycles is the combined annual output of said two cities. Thirty-three thousand hands are employed in the factories. The exports amounted to nearly $7,000,000 and capital invested to $85,000,000. 1,955 patents for inventions relating to bicycles were granted in Great Britain in 1896.—Oesterreichische Monatschrift.

NEW NAVAL WAR GAME.

ONE of the most pregnant difficulties in framing a Kriegspiel is so to adjust the multitudinous factors that no one factor shall possess undue prominence—a far harder task than can be imagined by those who have not attempted it. The framing of rules is easy enough, the concentrated verdict of a dozen or so naval officers specialists in say gunnery is easily frozen down into the necessary conventions; but how is the due proportion between, say guns and torpedoes to be obtained? Gunnery, torpedo, tactical questions and navigation generally, each is considered more or less omnipotent by its own special votaries. The engineering branch, again, has a considerable importance. On board a destroyer it has, perhaps, a major importance. The best of commanders is well-nigh helpless in a destroyer if he have an incompetent engineer, while he who has a smart man below can depend on that instant appreciation of what is required which alone can produce satisfactory results. In assessing a destroyer, therefore, we find that for full efficiency engineering and navigating matters stand first, hand in hand, then gunnery and torpedo. No rules that did not bear all this in view could be satisfactory as regards the part of destroyers in a sea Kriegspiel. And so, in various proportions, for all other types.

The multitudinous methods by which some sort of approximation of all these varying relative values have been made are too many and too tedious to enter into fully here; from first to last this question, and this one alone, has occupied the author for a matter of nearly ten years.

At the present time maneuvering qualities of all kinds, engineering and torpedo, have all been met and satisfied; but gunnery is yet to some extent in nubibus. The vast gap between proving ground experiments on the one hand and the fragmentary practical results at the Yalu and Angamos makes it almost impossible to construct an absolutely satisfactory mean. At the present day the average naval officer, whether gunnery or "salt horse," has a strong belief in the efficacy of armor even at close range; but, on the other hand, there are other authorities whose opinions must bear very great weight who consider the Yalu action as no proof at all of this. All we really know is that the Chinese solid shot made no serious impression upon armored structures, and that was but what had been foreseen. We have no precise information as to what the Japanese fired from their big guns. We do not know whether it was common shell or armor-piercing shot that failed to penetrate the 14-inch compound armor of the "Chen Yuen," and everything turns on that point; the most sanguine theorist would never expect common shell to get through the equivalent of 20 inches of iron. There being this difficulty, there is nothing for it but to base the rules as to armor resistance upon theory—a theory that has to incorporate not merely penetration upon direct impact, but all side issues, such as oblique impact and the like, many of which vary with the projectile employed. In a great measure, of course, these things resolve themselves into a question of range; and the approximations employed are sufficiently definite to make the question of a ship's liability to damage in any particular place some sort of approximation to what may reasonably be expected in actual battle. Some notes, therefore, upon casualties in the engine room department during actions recently played by naval officers may be of interest to readers of The Engineer.

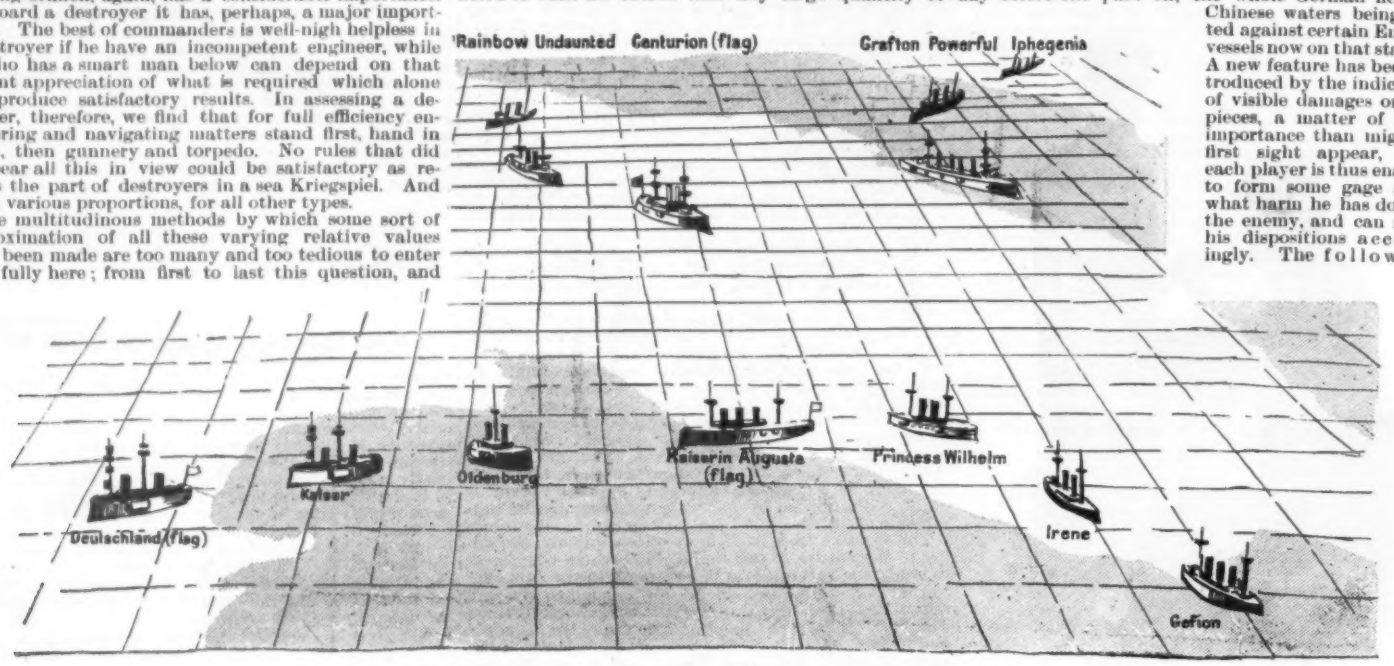
I would not, of course, venture to assert that the results should be considered as occupying any position akin to actual experiment, but insomuch as the chances of being hit in any particular place under any particular conditions are as realistic as possible; and, further, since the maneuvering of the ships—there is one player to each ship—was undertaken by and according to the ideas of men who, either now or at no distant date, would command our battleships should we be involved in war—for these and other minor reasons, what happened to the engines may be claimed as affording an index at least equal to theory.

It should be explained that a ship's speed in the game is presumed to suffer if the water line forward is holed to such an extent that any large quantity of water could enter and depress the bow. Speed, too, is lost if the funnels are knocked about, steam pipes injured, and the like. Finally, after destruction of coal protection, the engine room is held liable to damage. This last is, perforce, upon a system of points in order to allow for shells that do not burst, and so forth—the game cannot do more than say, after receiving such and such a fire your engines would certainly be done up. The lesser chance of a ship being hit on the water line than higher up is allowed for; for this reason good chances are given.

Owing to the difficulties in handling a fleet, the great majority of actions have been single ship actions, or one large ship against two small ones. In these practically every type of vessel has at some time or other been engaged, and every method of water line protection tested.

It might be supposed that given two ships of exactly equal strength — two second-class cruisers of the "Apollo" class, for example—an action between them must result in something of the Kilkenny cat order—mutual destruction. Curiously enough, in no single instance has this happened. It might be pointed out that he becomes impotent before he has achieved his end. Vice versa, an attempt to carry out (a) may leave him superior in gun power, but with speed so reduced that the enemy can ram or retire at discretion, and there being no torpedoes to dread in a second-class cruiser action,* the ram has to be reckoned with. The combined attack (c) needs an infinity of judgment, or it must mean a between-two-stools fate: (a) is difficult too, since there is no knowledge except by inference as to what has been done to the enemy, and a part already destroyed may be fired at over again and energy thus wasted.

By far the largest fleet action yet attempted was played in the ward room of H. M. S. "St. George" the day before she paid off, the whole German fleet in Chinese waters being pitted against certain English vessels now on that station. A new feature has been introduced by the indication of visible damages on the pieces, a matter of more importance than might at first sight appear, since each player is thus enabled to form some gage as to what harm he has done to the enemy, and can make his dispositions accordingly. The following



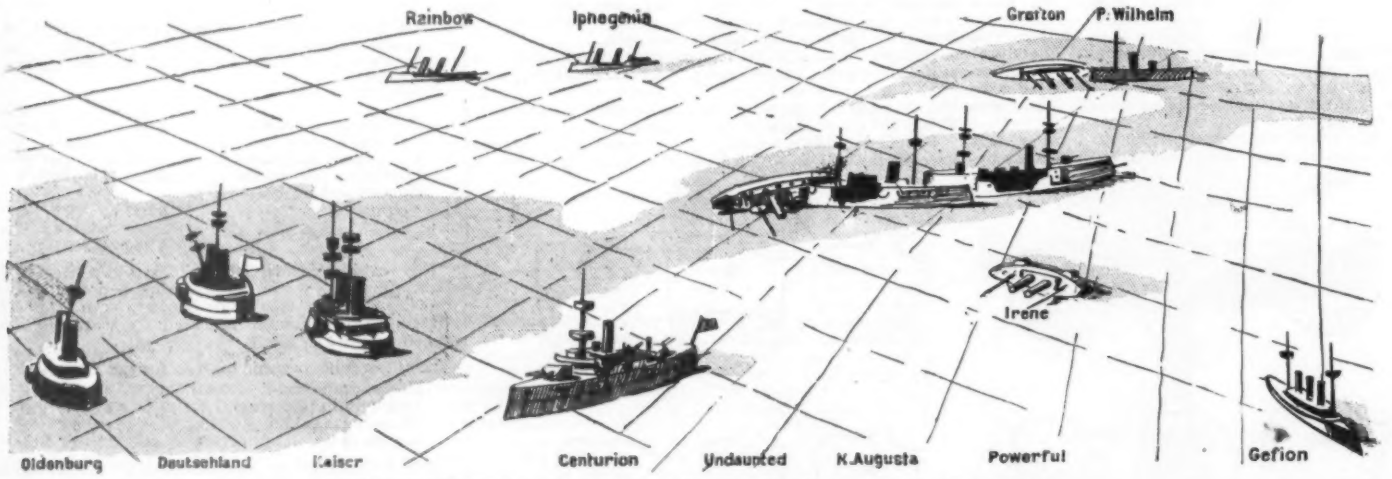
BATTLE BETWEEN ENGLISH AND GERMAN SHIPS—FIRST STAGE.

were the ships engaged and the speeds allowed them:

Red side, English: Battleship "Centurion," flag, 18 knots; armored cruiser "Undaunted," 15 knots; first class cruisers "Powerful," 21 knots; "Grafton," 18 knots; second class cruisers "Rainbow," 18 knots; "Iphigenia," 18 knots.

Blue, German: Battleships "Deutschland," flag, 12 knots; "Kaiser," 12 knots; "Oldenburg," 12 knots; first class cruiser "Kaiserin Augusta," flag, 18 knots; second class cruisers "Princess Wilhelm," 18 knots; "Irene," 18 knots; "Geflon," 18 knots.

It will be seen that the English fleet contained, as a rule, more powerful but numerically inferior units—four fighting ships against six, and an advantage in speed. Speed, however, was a factor that had absolutely no bearing on this particular fight. The English ships were under command of Lieutenant St. John, of the instructional flotilla, destroyers, flying his flag in the "Centurion;" the German "mailed fist" being represented by Captain French, with his flag in the "Deutschland;" while Surgeon Clayton acted as second in command, controlling the cruiser division from the "Kaiserin Augusta." As a general rule, the



BATTLE BETWEEN ENGLISH AND GERMAN SHIPS—LAST STAGE.

players of German ships were those officers who had participated in the Benin expedition. A number of other officers were present as referees or spectators, and every rule was strictly enforced.

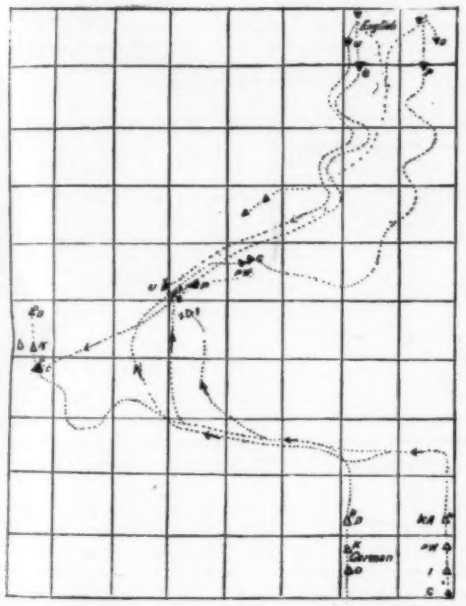
The combatants having selected their formations, the pieces were placed on the table at 10,000 yards distance. Both fleets went into action in double column of line ahead, battleships forming the port German division, while the English had the "Centurion," "Undaunted" and "Rainbow" as the starboard division. Both fleets approached each other very warily, slowing down to a nine knot speed. Not until the leading vessels were well within 4,000 yards was there any firing. The "Deutschland" and "Kaiserin Augusta" then

*No one has yet attempted to use above-water tubes—the risk is too great. No one would be likely to in real action.

opened with high explosive shell, the four leading English ships, now in a bow and quarter formation, replying in kind. Saving for one high explosive shell that fell on the quarter deck of the "Deutschland," through that ship being end on, and wrecked her stern, all the shots missed or failed against armor. Immediately afterward the German fleet altered course eight points in succession, and came into single line ahead. From that time onward, till all station was lost, they more or less preserved this formation, steering north and very gradually edging in toward the English. In altering course, however, the "Princess Wilhelm" was badly hit; she hauled out of line, and remained to leeward most of the action.

The British, getting into columns of line ahead, bore southwest, altered course eight points, then eight points back again, then altered once more, making a zigzag course for the center of the German line. During these maneuvers the "Powerful" was a target for at least four German ships, who, attacking with high explosives, completely wrecked her amidships, blew away her bow gun, and practically put her hors de combat, although not a single casemate had been actually penetrated. The "Centurion" also was hit amidships, losing a funnel and four guns. The German shells failed, of course, against her armor, and with her big guns she began to tell upon the "Deutschland," firing Palliser shell that got through the thinly armored battery. The "Oldenburg" suffered little less severely, while the "Kaiserin Augusta" was struck much as the "Powerful" had been, though not so badly.

The battle was, however, still quite undecided when the "Centurion" and "Undaunted" got into line abreast and steamed straight at the now straggling and irregular German line. Some four cables astern came the "Grafton," astern again the "Powerful" was endeavoring to turn. At the same time the "Deutschland" signaled for the "K. Augusta," "P. Wilhelm" and "Irene," that have bow submerged tubes, to try and torpedo the "Centurion," against whose armor all guns were useless. This they hauled out of line to do, but the "Centurion" was coming up so fast



MOVEMENTS OF THE ENGLISH AND GERMAN FLEETS.

that only the "Irene" dared to turn, the "P. Wilhelm," which had been to leeward, forging ahead and circling to get the other side of the English flagship. By this time ships were barely 1,000 yards apart, but the firing grew so wild and careless that much less harm was done than might have been expected, solid shot being wasted on unarmored ships, and high explosive shell against thick armor—the provision made in the rules for "moral effect" was beginning to tell. The "Irene" was, however, raked by common shell from the four big guns of the "Centurion" and sunk before she could fire a torpedo. The "P. Wilhelm" got within torpedo range, but could not bring her bow to bear, and so passed up between the "Centurion" and "Undaunted," barely a cable from either. Both ships fired torpedoes at her, the latter having boldly risked loading an exposed above-water tube. Both these torpedoes missed, but the "Centurion's" passing on hit the "Undaunted," whose battery had just been raked by solid shot from the "Kaiser," while a shell had blown away her bow, and she began at once to sink.

The "P. Wilhelm," unhurt, passed on and torpedoed the "Grafton," which had fired at her but hit the "Centurion" instead. At the same time the "Kaiserin Augusta," either unable to steer or else fearing to turn, collided with the sinking "Undaunted." Before she could back out, the "Powerful," drifting helplessly onward, rammed her a glancing blow, and her friend the "Gefion," firing "into the brown," did her some unintentional hurt also. The "Rainbow" and "Iphigenia," coming up, the "K. Augusta" had to strike; while the "Gefion," turning, made away. The "Centurion" was now directly astern of the "Kaiser," turning to get her submerged tubes to bear. Right ahead the "Oldenburg" lay "on fire;" beyond the "Kaiser," whence not a gun would bear, was the "Deutschland." Unexpectedly her flag came down; the three ships struck to force majeure. They had no torpedoes; their guns were powerless against the "Centurion's" armor; and it was now discovered that nearly all these guns were disabled. The "P. Wilhelm" also struck, being unable to escape.

The most curious thing about the action was the survival of the weak ship. The "Gefion," which was in the thick of the fight, was never once hit. The "Iphigenia" and "Rainbow"—which, however, kept more away—were practically untouched. The "Irene," till the "Centurion" raked her, had not been hit, the reason being that both sides attacked the stronger vessels, ignoring the lesser as of small account. It may be remembered that at the Yalu weak cruisers survived in a similar fashion.

The losses, etc., on either side were:—English: "Undaunted," sunk; "Grafton," sunk; "Powerful," sinking condition. German: "Deutschland," "Kaiser," "Oldenburg," disabled and captured; "Irene," sunk; "Princess Wilhelm," captured; "Kaiserin Augusta," captured.

The English victory was entirely due to the "Centurion's" superior power. Two British ships were sunk, and the "Powerful" very near it, while only one German was actually sent to the bottom. The failure of the "Powerful" was due to the concentrated attack on her with high explosives. Not a single casemate was put out of action through penetration; at the range there was no gun in the German fleet able to do so; the attack on her displayed very good judgment.

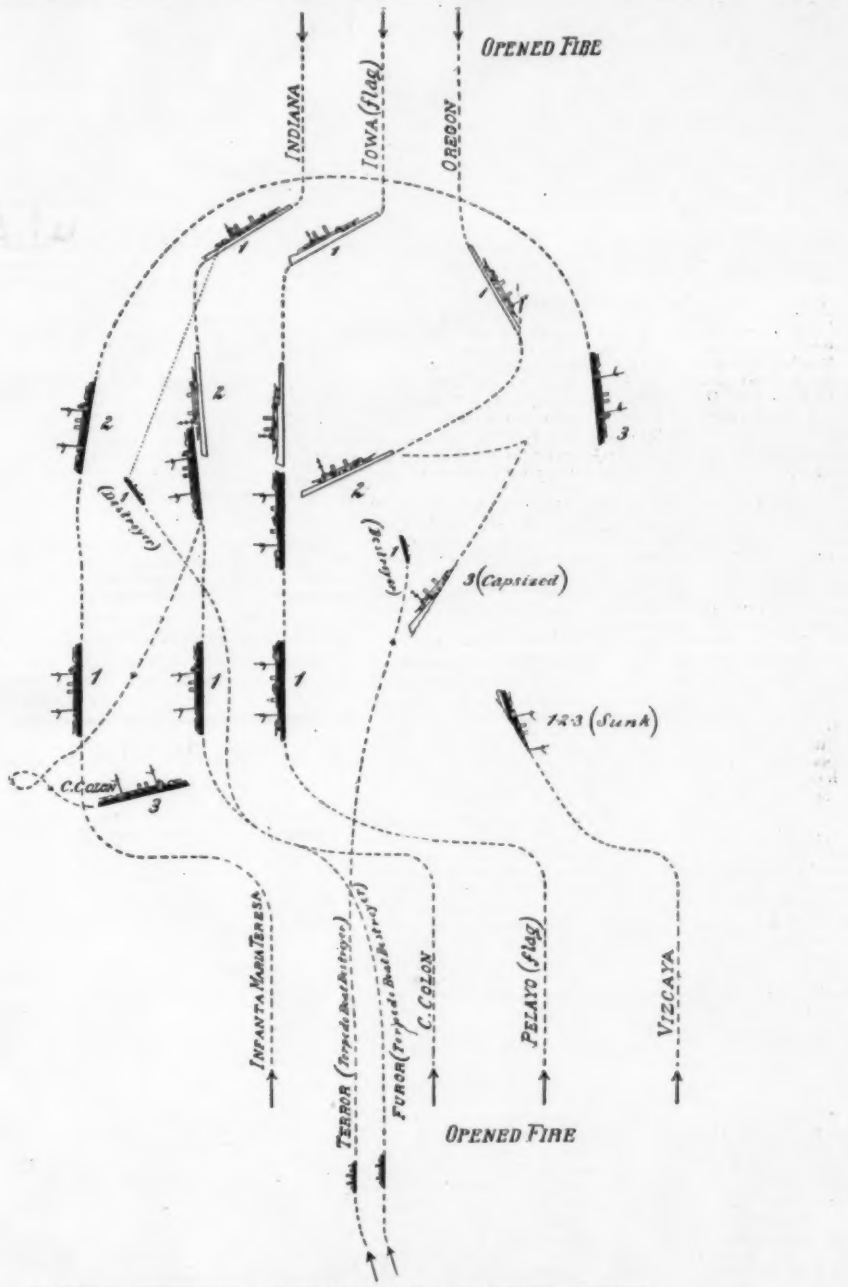
A number of hits were made on friends. So soon as the results of firing obliterated distinguishing marks it became practically impossible to tell friend from foe, or in the melée to insure a clear aim. Another noticeable thing was that the shooting at close quarters was wilder and more inaccurate than at two or three thousand yards, doubtless due to the excitement engendered by close action. This, it may be observed, is exactly in accordance with the theories of most naval officers.

Absolutely no causalties were sustained in the engine-room departments. In some measure this is to be attributed to a general increase in the value allowed for coal protection that has been deemed advisable; but it must also be put down to the small amount of armor-piercing projectiles that were fired. Engines have little or nothing to fear from common shell or high explosives, unless in the case of a "rake." The boilers of the "Irene" would possibly have been destroyed from this cause. It may also be noted that later the "Rainbow" and "Gefion" tried conclusions. The "Rainbow," ignoring the German's battery, fired consistently at her boilers, and destroyed them, thus capturing the ship.

In response to numerous inquiries as to how the game is played, we have to state that owing to certain small details of rules not being yet finally settled, and the game as yet only privately and provisionally published, the inventor does not wish the rules to be publicly known. The game will, however, be on general sale in the course of two months or less, before which time we hope to publish an article treating on the principal rules, and their "why and wherefore." In the meantime we are able to state that over fifty naval officers have already recorded their opinions that the game simulates the movements of ships in action remarkably closely, and enables any problem to be worked out with what appears to be a singularly true approximation to the real thing.

On Monday, February 28, a naval Kriegspiel fleet action that embodied one or two points not yet attempted was fought on board H. M. S. "Trafalgar" between typical Spanish and United States warships. Some effort was made to test the effect of destroyers being in company with a fleet, and if the results were not dramatic, they certainly went to prove that destroyers have distinct value, not merely as a menace, as usually allowed, but even as a protection from gun fire to their parent ships.

The United States fleet was represented by the three powerful battleships "Iowa" (flag), "Indiana" and "Oregon," each of which carries four 12-inch guns, eight 8-inch and several either 6-inch or 5-inch quick-firers. They were under Lieutenant Haworth-Booth, R. N., as admiral. The Spanish fleet consisted of more numerous but inferior units. The battleship "Pelayo," a belted vessel of French type, that carries two 12·5-



BATTLE BETWEEN AMERICAN AND SPANISH FLEETS.

inch, two 11-inch guns, one 6-inch quick-firing and twelve 4·7-inch quick-firing. This vessel acted as flagship, and was played by Lieutenant James, R. N. The other vessels were armored cruisers, the "Cristobal Colon," a ship almost completely covered with 6-inch Harvey steel armor, carrying two 10-inch, ten 6-inch quick-firers and six 4·7-inch quick-firers; and the "Infanta," "Maria Theresa" and "Viscaya," both enlarged editions of our "Undaunted" class, mounting each two 11-inch Hontorio guns in barbettes that are armored, and a battery of ten unprotected 6-inch quick-firing guns. With this fleet there were also present the two Clydebank destroyers "Furor" and "Terror," particulars of which have already appeared in The Engineer. These were allowed a speed of 21 knots; all the other vessels had 15 knots, except the "Cristobal Colon," which was given 18 knots. This vessel was played by Lieutenant Kawashima, of the Imperial Japanese Navy, who acted as second in command. The Spaniards being notoriously bad gunners, the players of these ships were handicapped by having to shoot as though the range were greater than it actually was. Altogether, despite seeming discrepancies, the combatants were very fairly matched.

Both sides adopted a line-abreast formation, the destroyers being kept well astern the Spanish ships. Fire was opened at 3,500 yards, the Americans concen-

trating upon the "Cristobal Colon," but firing common shells, which failed against her armor. In the positions adopted the advantage was all in favor of the American ships, who have many more guns bearing right ahead. On the other hand, it was advantageous for the weakly Spaniards to settle matters without delay; they also wished to use their destroyers. Presently, however, they altered course eight points to port, in order to get their broadsides to bear at nearer range. The "Viscaya," which was played by the chief engineer, was badly hit in the water line belt by solid shot at this juncture, and her player giving it as his opinion that his boilers were done for, she drifted a little way, and then came to a standstill for the rest of the action, using her guns but not moving.

The Americans, who were moving slowly, now altered course to starboard, saving the "Oregon," that went to port, and seeing that by following his original course he would be rammed, the Spanish admiral turned to starboard, thus threatening to ram the enemy. He was now doing his best speed. At the same time the destroyers came up at full speed, coming out from under cover. The "Furor" discharged a torpedo at the "Indiana," but missed; the "Terror" did not get near enough. The three Yankees opened a fire upon them with every gun, big and small, sinking both. The respite was of value to the Spaniards, however, for using high explosives, they wrecked the unarmored bows of both the "Indiana" and "Iowa," just as these altered course bow on to them. A bow-to-bow ram was now unavoidable, and the Americans, with their bows under water being less handy, were umpired as the victims, the "Indiana" falling to the "Cristobal Colon," the "Iowa" to the "Pelayo." Apparently, however, the American "admiral" had foreseen this, as the "Oregon," that had taken a separate course, circled round and came into the "Pelayo." Just before she rammed she gave her whole broadside, with alternate solid shot and high explosive shell, into the motionless "Viscaya," sending her to the bottom.

A little before the ramming a curious incident took place. Both the "Iowa" and "Pelayo" had loaded their above-water bow torpedo tubes. By the rules, if the torpedo compartment is hit when a tube is thus loaded, even chances of the torpedo being exploded must be thrown. The "Iowa" fired and missed, and was hit by a shell immediately afterward. The "Pelayo" did not fire, but was hit by high-explosive shell from four guns of the "Indiana" that would not bear on the destroyers. For each of these she had to throw the chances, yet escaped; just the sort of thing that might happen in real action—somewhat analogous, indeed, to a real incident at the battle of Asan in the China-Japanese war.

The fleets were now reduced to the "Cristobal Colon," much wrecked; the "Infanta Maria Teresa," little hurt, save that most of her 6-inch guns were disabled; and the "Oregon," which fired everything at the "Cristobal Colon" without any particular effect, the high-explosive shells being useless against the 6-inch Harvey steel. The "Maria Teresa" circling round, also fired high explosives from her big guns, hitting both bow and stern of the "Oregon," and as these unarmored ends were already damaged, their destruction was complete. Things must, however, have gone badly with the Spaniards when the "Oregon," which still had nearly all her guns, began to turn sharply at her fullest remaining speed, and was given as capsized in consequence. The thin armor below the fore turret had been badly hit, and this turret was presumably almost level with the sea; any action such as her player attempted must have resulted in similar disaster.

Victory, therefore, remained with the Spanish "many." It is the first action yet fought in which the weak unit in numbers has defeated the stronger unit in less quantity. But for the presence of the destroyers "Furor" and "Terror" such a result could hardly have been achieved, for the tremendous fire which the American admiral poured upon these little vessels so as to make absolutely certain of destroying them—a thing, by the way, that he only just succeeded in doing, in one case, too, not before the torpedo was fired—this tremendous fire at close range would have been very serious to the Spanish ships. Considerable credit was due to the American admiral for the manner in which he met this "mosquito flotilla" attack. He had so ignored them before that the Spanish side imagined he had completely forgotten them. The destroyers were well handled, they took skillful advantage of cover in case they had been fired at, and the Spanish admiral ordered them to attack at what was certainly the most opportune moment. It is a pity in some ways that the Americans had no light craft allowed them, as it would have been extremely interesting to note what then happened. The United States navy is, however, singularly devoid of small ships, so their being without them was as things should have been for purposes of comparison. The famous ram "Katahdin" was to have been with the Americans, but, unfortunately, there was not an extra player for this vessel, so she had to be omitted. It is hardly possible for any player to undertake more than his own ship; nor, indeed, does the game anticipate or allow for such a contingency—one man one ship being the main idea upon which it is based.—The Engineer.

[Although in this particular case the game, as worked out under the rules, resulted in a victory for the Spanish fleet, there can be no doubt that in nine cases out of ten the less numerous but far more powerfully armed and armored American ships would win. In the first place, the fight was carried out chiefly in the end-on position, in which the American ships have a concentration of fire unapproached in any navy. The end-on armor-piercing fire of the Spanish ships would aggregate one 10-inch, four 11-inch and one 12½-inch gun, or six in all. Against this the American fleet could bring to bear just three times the number of armor-piercing guns, or twelve 8-inch, two 13-inch and four 13-inch.

Moreover, the armor protection of the American ships is infinitely superior, consisting of from 15-inch to 18-inch Harvey steel extending without a break from the guns to the water line, whereas the Spanish turrets are unprotected from their base to the armor belt. This unprotected base would be speedily wrecked by the twelve 8-inch guns of the enemy and the turrets thrown down into the wreckage below. The most valuable lesson of the game is the moral effect produced by the deadly torpedo boat destroyers.—ED.]

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